

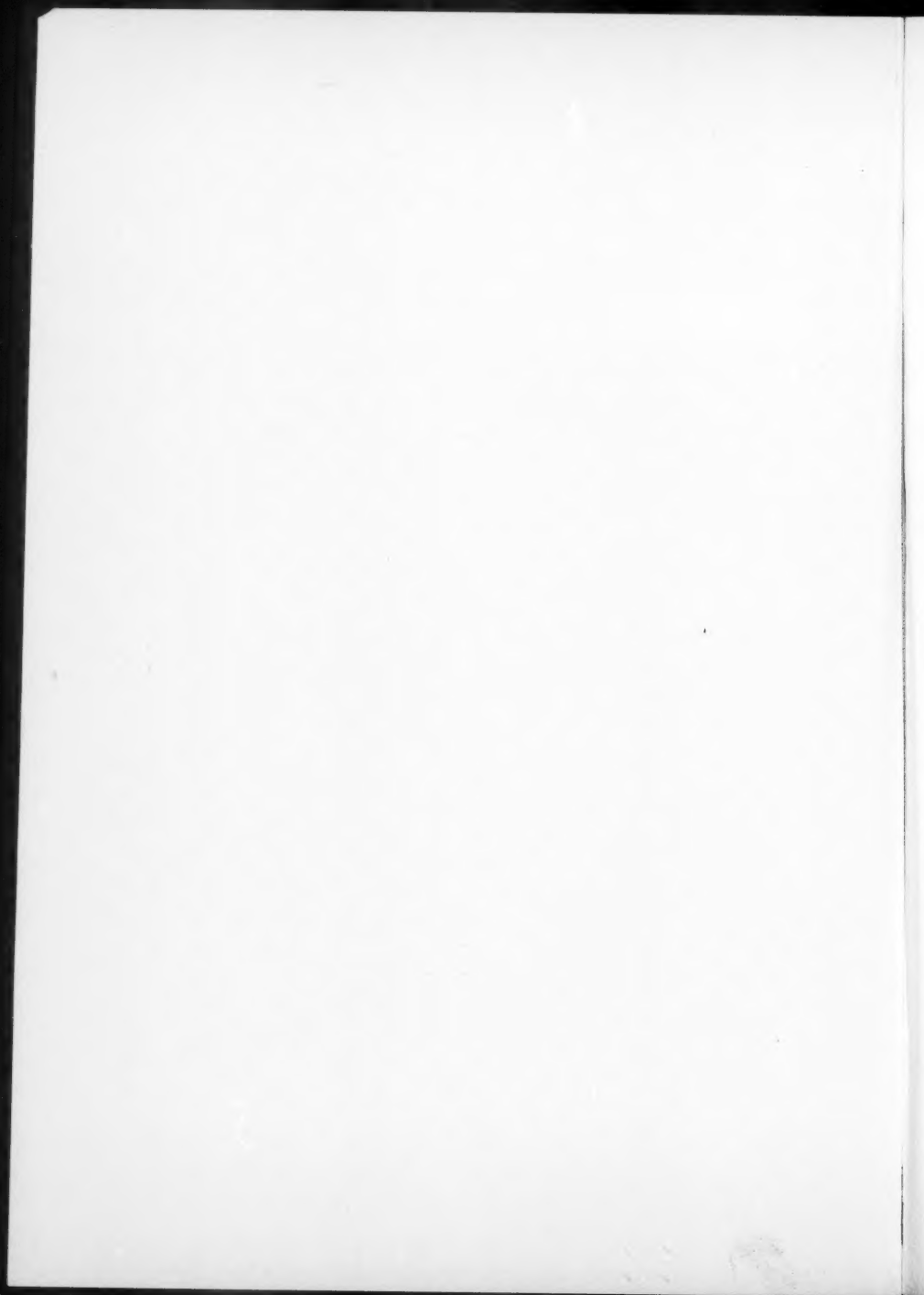
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INDEX

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ABSTRACTS OF RECENT MONOGRAPHS

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CHEMISTRY INCLUDING METALLURGY SERIES

APS Ch 1

UDC 665.112.2

JART, A: *Fat Rancidity. Summaries of Papers Presented at the 2nd Scandinavian Symposium on Fat Rancidity.* Acta Polytechnica Scandinavica (Acta P. 242/1958) Chemistry including Metallurgy Series 1, Copenhagen 1958, 72 pp. Sw. Kr. 7.00

The report consists of summaries with illustrations supplemented by notes on the subsequent discussions of the 18 papers delivered at the 2nd Scandinavian Symposium on Fat Rancidity. The symposium was held at Elsinore, Denmark on September 9-11, 1957, and was attended by 86 fat and oil scientists and technologists from the five Scandinavian countries.

The subject of the symposium was the microbial and oxidative rancidity of fats as well as other alterations reducing their quality during processing, storage and transportation. The papers dealt with fat and oil processing, manufacture of margarine, herring meal, cereal products, and dairy products and related subjects.

APS Ch 2

UDC 541.9

ERÄMETSÄ, O, *Ion Characteristics. A New Way of Assessing the Chemical Properties of Ions.* Acta Polytechnica Scandinavica (Acta P. 249/1958). Chemistry including Metallurgy Series No. 2, Helsinki 1958, 22 pp. Sw. kr 7:00

The new concept "ion characteristics" classifies the ions according to their chemical behaviour. By using ion characteristics and ionic radius as co-ordinates a diagram is obtained in which the ions with a noble gas configuration form a periodic system and the other ions occupy positions corresponding to their character. The ion characteristics and the reduced potential give a diagram in which the course of the qualitative analysis is seen in its every detail. The same diagram also shows the difference between chalcophilic and lithophilic elements. The geochemical camouflage appears from one diagram.

ERÄMETSÄ, O, *On the Decomposition of Polash Felspar*. Acta Polytechnica Scandinavica (Acta P. 260/1959). Chemistry including Metallurgy Series No 3, Helsinki 1959, 19 pp. Sw. kr. 7: 00

In the work, a method is presented by which the hydrogen fluoride liberated when superphosphate is made from apatite starts a circulation process, which during the maturing of superphosphate causes the decomposition of the felspar added to the mixture.

The dependence of the results on various circumstances is demonstrated by reaction-kinetic observations. The experimental laboratory investigations gave results which agreed well with the theoretical calculations. It was possible to decompose felspar ten times the quantity that the equivalent ratio would presuppose.

Finally, an industrial scheme is presented by which the potassium and the aluminum of felspar are separated from each other.

Report of the Committee on Slaughtering Methods Appointed by the Danish Academy of Technical Sciences at the Request of the Ministry of Justice. Acta Polytechnica Scandinavica (Acta P. 264/1959), Chemistry including Metallurgy Series 4, Copenhagen 1959, 35 pp. Sw. Kr. 7.00.

The report contains in a summarizing form the committee's investigations on the effect of electric stunning on the quality of pork, particularly whether electric stunning could cause hemorrhages in the ham, loin and belly and in general more perishable meat.

It is shown that deleterious punctate hemorrhages in the muscles can be avoided if the time interval between the interruption of current flow and sticking is reduced to about 5 sec. Organoleptic and chemical investigations showed no difference in the perishability of the meat from stunned and unstunned hogs. The pH in macerate of m. gracilis from hams from unstunned and stunned hogs was the same.

MÄKIPIRTTI, S, *On the Sintering of W-Ni-Cu Heavy Metal*. Acta Polytechnica Scandinavica (Acta P. 265/1959), Chemistry including Metallurgy Series 5, Helsinki 1959, 69 pp. Sw. Kr. 7. 00.

A study has been made of the phenomena which occur when a W-Ni-Cu powder mixture, belonging to the range of heavy metal alloys, is sintered. The isothermal shrinkage of the powder specimens, as a function of time, was studied in the temperature interval 500°-1450°C with the aid of an optical dilatometer. On the basis of accurate shrinkage observations, it could be noted that the sintering obeyed a certain time law valid in the entire sintering range for pure substance systems, as well as for the investigated multi-component systems. The new sintering equation has the form

$$(1 - \alpha)^{1-i} = 1 - (1 - i) [t \times k_1 \exp(-Q_1/RT)]^n,$$

where α is the fraction of voids disappearing in sintering, i is the impingement exponent, n the time exponent, t the time, k_1 a constant, and Q_1 is the activation energy. The new sintering equation is in close agreement with existing theory, as well as with empirical observations. The activation energy of shrinkage for the investigated mixtures was of the same order of magnitude as for the self-diffusion of that component, which in a certain temperature interval was effective in sintering. In the light of the new sintering equation, the effect of the green density was also studied.

PAULSEN, Arnfinn: *Constitution des Quatre Isomeres de Position des Chlors et Aminométhylbenzodioxannes-1,4 Substitués dans le Noyau Benzenique*. Acta Polytechnica Scandinavica (Acta P. 270/1960) Chemistry including Metallurgy Series No. 6, Oslo 1960. 94 pp. Sw. Kr. 7:00.

L'auteur a préparé une série des chloro et aminométhylbenzodioxannes-1,4 substitués par des groupements différents (acétyl, carboxy, carbonamido, cyano, N,N-diméthylcarbonamido et benzoyl) dans les quatre positions possibles du noyau benzénique.

Des produits encore plus variés ont été préparé par substitution dans les positions 6 et 7, ou l'obtention de matière première est plus facile que dans les positions 5 et 8.

DAHLGREN, SVEN-ERIC, *Physico-Chemical Background of Phosphoric Acid Manufacture by Wet Processes*. Acta Polytechnica Scandinavica (Acta P. 271/1960), Chemistry including Metallurgy Series 7, Stockholm 1960, 15 pp. Sw. Kr. 7:00.

It is shown that nucleation occurs for supersaturated systems only above a threshold value and that the rate of crystal growth at technical state of things is proportional to the supersaturation. The theoretical background is outlined. Three modifications of calcium sulfate, namely dihydrate, α -semihydrate, and anhydrite II are formed in phosphoric acid processes.

Equilibrium curves obtained in different ways are compared, and an equilibrium diagram for phosphoric acid-sulfuric acid mixtures is given.

The consequences of nucleation conditions applied to phosphoric acid processes are discussed. The non-workable zone between the dihydrate and the semihydrate processes depends on simultaneous formation of dihydrate nuclei.

Shape and size of calcium sulfate crystals depends to a large extent on specific impurities in the phosphate rocks.

The kinetics of nucleation and transformation of the different calcium sulfate modifications are discussed and the formation of dihydrate and semihydrate in the stability region of anhydrite II explained.

SUNDIUS, N., *Felspar and its influence on the reactions in ceramics during burning*. Acta Polytechnica Scandinavica (Acta P. 272/1960) Chemistry including Metallurgy Series 8, Stockholm 1960, 29 pp. Sw. Kr. 7:00.

A survey of the properties of Na-, K- and Ca-felspar and of the viscosity of their glasses. The miscibility relations and the development of perthitic intergrowths of the alkali felspars are discussed.

Of the different kinds of felspar mined for and used in ceramics representative analyses were collected and their contents of K-felspar, albite, anorthite and quartz calculated.

The thermodynamic properties of mixtures of quartz and different kinds of felspar are discussed and the importance of the varying viscosity produced by different felspars is pointed out.

Some experiments show the increased speed of vitrification produced by albite and the strong fluxing power of admixtures of lime, magnesite and barium carbonate.

DAHL, Olle: *Gamma-Irradiation of Vacuum-Packed Sliced Meat Products*. Acta Polytechnica Scandinavica (Acta P. 276/1960) Chemistry including Metallurgy Series 9, Stockholm 1960. 24 pp. Sw.Kr. 7:00.

Vacuum-packed sliced bacon, cooked ham, cooked cured beef, smoked cured horse meat, thick bologna and liver paste were γ -irradiated with doses of 0.1, 0.2, 0.5, 1.0 and 2.0 megarad and stored at 22°–28° C.

At a dose level between 0.2 and 0.5 megarad off-flavour appeared in all items. Change of colour was observed after about one week's storage. Doses of 1.0 and 2.0 megarad made the products turn brittle, evidently due to non-enzymatic destruction of the tissue.

A dosage of 2.0 megarad was sufficient to achieve practical sterility in all products under the conditions used.

Long-term storage was limited owing to oxidative rancidity and destruction of texture.

ENEBO, Lennart and PEHRSON, Stig O.: *Thermophilic Digestion of a Mixture of Domestic Sewage Sludge and Cellulose Materials*. Acta Polytechnica Scandinavica (Acta P. 281/1960) Chemistry including Metallurgy Series 10, Stockholm 1960, 40 pp, Sw. Kr. 7:00.

Basic problems in the thermophilic digestion of domestic sewage sludge and cellulose sludge from pulp factories have been examined. The course of digestion was followed by means of analysis of the material left undigested. This permitted an estimation of the individual rates with which cellulose, protein and fat were converted.

It was shown by means of batchwise and semicontinuous digestions that a mixture of 75% noli fibre and 25% domestic sludge probably can be satisfactorily converted using a semi-continuous process.

The process must be kept under good analytical control, the protein decomposition stimulated by not too high a temperature and the nitrogen level kept above 0.2 g/l, if necessary by the addition of an ammonium salt. In addition experiments were made on the utilization by methane bacteria of organic compounds known to be of significant metabolic importance.

ASCHAN, L. J.: *Studies on the Ternary System Cu-Mg-Si*. Acta Polytechnica Scandinavica (Acta P. 285/1960) Chemistry including Metallurgy Series No. 11, Helsinki 1960. 64 pp. Sw. Kr. 7:00.

The copper corner of the ternary diagram Cu-Mg-Si has been studied by X-ray diffraction methods and thermal analysis. The results are presented in the form of an isothermal section at 450° C (Fig. 10), and a projection of the liquidus surface on the basal plane of the diagram (Fig. 11, with details in Figs. 14 and 15). Some micrographs of alloys are included.

No hitherto unknown ternary phases have been found. The high temperature phases β , α and γ (binary system Cu-Si) disappeared in the isothermal section at 450°.

The four-phase equilibria and the ternary eutectic points found are presented in Table VIII.

ERÄMETSÄ, Olavi and KOLEHMAINEN, Antti: *A Modification of the Ion Characteristic to the Glass Theory and the Glasses Coloured with Lanthanons*. Acta Polytechnica Scandinavica (Acta P. 290/1960) Chemistry including Metallurgy Series No. 12, Helsinki 1960. 21 pp. Sw. Kr. 7:00. Finnish Contribution No. 18.

The study presents a new system which is based on quantities of nuclear physics and logically explains the behaviour of different elements in glass. As here the lanthanides enter the region of intermediate oxides, lanthanide glasses have been made from very pure base glasses by employing every coloured lanthanide except thulium. The absorption spectra of these have been measured. With increasing lanthanide amount, the colour increases slowly at first, but from a certain point, it begins to increase more rapidly following strictly the law of Lambert - Beer. This is explained in such a way that, owing to their intermediate character, the lanthanides first become fixed in the silicate skeleton and only after this replace cations.

ALERTSEN, Aase Rye: *Ageratochromene, a Heterocyclic Compound from the Essential Oil of Ageratum boustonianum Mill.* Acta Polytechnica Scandinavica (Acta P. 293/1961) Chemistry including Metallurgy Series 13, Oslo 1961, 66 pp. Sw.Kr. 7:00. Norwegian Contribution No. 10.

From the essential oil of *Ageratum boustonianum* Mill. 6:7-dimethoxy-2:2-dimethylchromene was obtained. The name ageratochromene was proposed for this substance. The structure of ageratochromene (m.p. 47.5°C) was determined by oxidations of the substance followed by synthesis of its dihydrocompound.

The infra-red spectra of nine chroman derivatives and of four 1:2:4:5-substituted benzene derivatives obtained during the experimental work, are discussed. Some simple 2:2-dimethylchromenes occurring in Nature are discussed in relation to the theories of A. J. Birch and F. Lynen in order to put forward a hypothesis for the possible biochemical synthesis of ageratochromene.

SUNNER, S. och WADSO, I.: *Measurements on Heat Effects accompanying the wet Carbonization of Peat in the Temperature Range 20 to 220 Degrees C.* Acta Polytechnica Scandinavica (Acta P. 297/1961) Chemistry including Metallurgy Series 14, Stockholm 1961, 40 pp. Sw. Kr. 7:00. Swedish Contribution No. 13.

A quasi-adiabatic twin-calorimeter was used for the determination of heat effects accompanying the wet-carbonisation of peat as studied in the temperature interval 20 to 220°C at a rate of heating of ca. 7°C per minute.

The amount of electrical energy necessary to heat a quantity of a 4% peat suspension containing 1 kg of peat, dry weight from 20 to 220°C was 125 to 175 kcal less than that used up by the same mass of water. From these results the negative value of the enthalpy change (= exothermicity) accompanying the wet-carbonization under conditions given above was estimated to be 50 kcal or less per kg of peat, dry weight.

ERÄMETSÄ, Olavi and KARLSSON, Kaj: *The Crystal Chemistry of some Sodium Polysulphides*. Acta Polytechnica Scandinavica (Acta P. 301/1961) Chemistry including Metallurgy Series 15, Helsinki 1961, 18 pp, Sw. Kr. 7:00. Finnish Contribution No. 23.

The study concerns nonaqueous sodium polysulphides. α -Sodium disulphide proved to be a monoclinic crystal with: $a = 4,40 \text{ \AA}$, $b = 5,33 \text{ \AA}$, $c = 3,81 \text{ \AA}$, and $\beta = 93^\circ 12'$; β -disulphide with: $a = b = 5,11 \text{ \AA}$, $c = 5,76 \text{ \AA}$, and $\beta = 88^\circ 44'$, and tetrasulphide with: $a = 8,01 \text{ \AA}$, $b = 8,24 \text{ \AA}$, $c = 8,82 \text{ \AA}$, and $\beta = 91^\circ 5'$. The trisulphide mentioned in the literature proved in X-ray examination to be a mixture of disulphide and tetrasulphide.

RUNOLINNA, Urmas: *Dry Magnetic Separation of Finely Ground Magnetite in a Rotating Magnetic Field*. Acta Polytechnica Scandinavica (Acta P. 303/1961.) Chemistry including Metallurgy Series 16, Helsinki 1961. 73 pp. Sw.Kr. 7:00. Finnish Contribution No. 25.

The behaviour of magnetite particles in a rotating magnetic field has been investigated by measurement of the velocity of the magnetite clusters, and by photography of their tumbling movement at different field frequencies up to 500 c.p.s.

The results of these investigations proved to be in agreement with the theoretical statements earlier presented by Laurila.

The main factors effective in a dry separation process have been investigated by separation tests with different magnetite ores, and by the employment of two different forms of separator.

The results of separation tests have been theoretically explained, and the optimum conditions for dry separation in a rotating magnetic field discussed.

The construction of dry separators has been analysed in the light of the findings made.

FORSS, K: *The Composition of a Spent Spruce Sulfite Liquor*. Acta Polytechnica Scandinavica (Acta P. 305/1961) Chemistry including Metallurgy Series 17, Helsinki 1961, 148 pp., Sw.Kr. 14:00. Finnish Contribution No. 26.

The organic components of a spent liquor from an industrial cook of spruce wood (*Picea excelsa*) that yielded a strong pulp have been studied by ion-exclusion chromatography employing a column of Dowex-50, X-2, H⁺, 100/200 mesh cation exchange resin 4 m high and 42 mm in diameter. Fractions containing primarily aromatic components, acidic hemicellulose components, polysaccharides, monosaccharides and acetic acid were obtained. The recovery amounted to 98.5 per cent of the dry organic matter in the original sample. The lignosulfonic acids separated into two peaks and were isolated in a high degree of purity. All the lignosulfonic acids had identical absorptivity ($1 \cdot g^{-1} \cdot cm^{-1}$) at 280 m μ , MeO content, equivalent weight, sulfur content, content of phenolic hydroxyl groups and absorptivity at 430 m μ after reaction with o-aminodiphenyl. Two other smaller peaks representing aromatic substances which differed from the lignosulfonic acids were also obtained. A substance was isolated from the acidic hemicellulose components which in all probability was O-(4-O-methyl- α -D-glucosyluronic acid)-(1 \rightarrow 2)-D-xylose. Five neutral polysaccharides were isolated; three composed of glucose and mannose, one of glucose, mannose and galactose and one of xylose. The conclusion was drawn from the uniformity of the lignosulfonic acids that their previous differentiation into α - and β -lignosulfonic acids has been a consequence of the experiment techniques employed.

SULONEN, M. S.: *Reinvestigations of the Copper-Cadmium Alloy System: The Alpha Phase Boundary and the Crystal Structure of the CuCd Phase*. Acta Polytechnica Scandinavica (Acta P. 313/1962) Chemistry including Metallurgy Series No. 18, Helsinki 1962, 22 pp, Sw. Kr. 7:00.
Finnish Contribution No. 30.

Powder X-ray methods have been used for the redetermination of the solidus and solvus of cadmium in copper as well as for the crystal structure analysis of the CuCd phase.

The general form of the solubility curve of cadmium in solid copper as determined by Raub is supported by the present results, which however place the solvus 10—20 °C higher in temperature, and show a steeper change in direction of the solubility curve at the peritectic temperature.

The CuCd phase is shown to have a MgNi₂-type (C 36) hexagonal crystal structure with $a = 5.0115 \text{ \AA}$ and $c = 16.21 \text{ \AA}$.

DAHLGREN, Sven-Eric: *The influence of impurities on viscosity and density in water solutions of phosphoric acid*. Acta Polytechnica Scandinavica (Acta P. 316/1962.) Chemistry including Metallurgy Series 19, Stockholm 1962. 20 pp. Sw. Kr. 7:00.
Swedish Contribution No. 16.

On the basis of the Forslind theory of solutions, a systematic study has been made of the effect on viscosity by different inorganic additions to phosphoric acid solutions at concentrations of interest in the wet-process manufacture of the acid. An additivity rule of the viscosity effect by anions and cations was established. An increase in the temperature reduces the relative influence by impurities. At constant temperature and ratio of impurities to phosphorus pentoxide, an increase of the acid concentration results in a steep increase of the viscosity effect by impurities. The viscosity action of organic matter in wet-process phosphoric acids is estimated from the difference between measured and calculated viscosity. A series of different wet-process phosphoric acids has been investigated. A preliminary rheological study of synthetic mixtures and wet-process acids shows that at high concentrations pure phosphoric acid solutions behave dilatant. In the presence of some impurities dilatancy is observed at considerably reduced phosphoric acid concentrations.

THE COMMITTEE ON FROZEN FOODS, DANISH ACADEMY OF TECHNICAL SCIENCES: *Consumer-Packaged Frozen Foods. Suggested Directions for Processing, Storage and Distribution*. Acta Polytechnica Scandinavica (Acta P. 319/1962) Chemistry including Metallurgy Series No. 20, Copenhagen 1962, 53 pp., Sw. Kr. 7:00.
Danish Contribution No. 15.

Based on the most recent scientific knowledge of the behaviour of consumer-packaged frozen foods, and after a survey on available frozen food regulations, codexes, etc. from a number of countries, general directions for their proper handling have been suggested with a view to the rational use of the existing storage and distribution facilities in Denmark.

Emphasis has been laid on the newest concepts of time-temperature tolerance of frozen foods bearing in mind that these are to be considered general rules with a number of exceptions.

The report discusses processing, packaging, freezing, storage, transportation, labelling, and microbiology and contains an abstract of the main conclusions and suggestions.

Fat Rancidity. Summary Report from the Third Scandinavian Symposium on Fat Rancidity held in Sandefjord, Norway 28-30 August 1961. Acta Polytechnica Scandinavica (Acta P. 320/1962.) Chemistry including Metallurgy Series No. 21, Oslo 1962. 4 + 108 pp., Sw. Kr. 14:00.
Norwegian Contribution No. 16.

This summary report from the Third Scandinavian Symposium on Fat Rancidity held in Sandefjord, Norway, 28-30 August 1961, contains digest of the 28 papers presented and of the discussion following each paper.

The Symposium, sponsored by the Scandinavian Council for Applied Research (SCAR), was organized by the Royal Norwegian Council for Scientific and Industrial Research. Attendance was limited to 90 fat and oil scientists.

The subject of the Symposium was the oxidative and biochemical rancidity in fats and oils as well as other kinds of deterioration of fats and oils during processing, storage and transportation.

The papers dealt with different problems in fat chemistry and technology, such as analyses of fats and oils, manufacture of margarine, soap, milk products, frozen fish and vitamins, and the effect of the feed fat on the quality of pork.

KORHONEN, U. and VILHONEN, E.: *On the calculation of activation energy in thermal activation rate processes.* Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 22, Helsinki 1963, 15 pp, Sw. Kr. 10:00.

It is shown that in thermal activation rate processes in which the activation rate has the form

$$(I) \quad v = v_0(x) e^{-E/kT},$$

the ratio of activation rates at two different temperatures, but which correspond to the same transformation degree, is equal to the inverse ratio of the corresponding times, so that the activation energy can be calculated from either equation (2) or (8).

When the activation rate has the form

$$(II) \quad v = \alpha(x) \cdot \beta(T) e^{-E/kT},$$

equations (2) and (8) give false values for the activation energy. The correct value has to be calculated from equations (18) or (20) which presupposes that function $\beta(T)$ is known, or that it can be determined simultaneously with correct value of activation energy. Furthermore, in this case the ratio of activation rates at two different temperatures and at the same transformation degree is equal to the inverse ratio of the corresponding times. The fact that the value for activation energy calculated by means of (2) or (8) is independent of the transformation degree, but is dependent on temperature, is a clear indication that the activation rate has the form (II).

When there are two activation energies in the same thermal activation rate process, these two energies can be solved simultaneously from activation rates determined at four different temperatures, and corresponding to the same transformation degree, if in addition the partial activation rates both have form (I).

KETTUNEN, P. O.: *Some Observations on the Fatigue Mechanism in Body-centred Iron*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 23, Helsinki 1963, 20 pp. Sw. Kr. 10:00.

This work reports on a study of the formation of slip bands and their further development up to ultimate fracture in Armco iron and spectroscopically pure iron, in conformity with the low and high range division of stresses suggested by Wood.

At low stress, rather narrow slip bands are observed, which during the further course of events seem to change into kinds of persistent bands and fissures. Ultimate fracture mostly occurs across the grain, following the fissures.

At high stress, most slip bands resemble those at low stress, but some of them tend to grow into long and broad bands. The higher the acting stress, the more pronounced is this tendency. When about 60 to 80 per cent of the entire life has passed, the grain boundaries tend to open, so that the ultimate fracture occurs along them. Only where no such openings are available does the fracture follow the fissures.

In the slowly cooled Armco iron, it has been found that the endurance limit increases with diminishing grain size, at proportionality consistent with $d^{-1/4}$. This suggests that the role played by grain size in the control of the entire fatigue phenomenon is of secondary nature.

The observations are discussed on the basis of the mechanism suggested by Low for unidirectional loading. The differences are thought to be due to difference in the height of jog in screw dislocation rather than different mechanisms.

JART, Aa.: *Infrared Spectra of Carboxylic Acid Derivatives. I. S-Benzylthiuronium Salts*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 24, Copenhagen 1963. 120 pp. Sw. Kr. 20:00.

The present paper deals with infrared spectra of 362 S-benzylthiuronium salts recorded in the range $625-4000\text{ cm}^{-1}$. Out of these 335 are salts of carboxylic acids, 1 of a sulphinic acid, 19 of sulphonic acids, 1 of an alkylsulphuric acid, 5 of nitrophenols and 1 of S-benzylthiuronium chloride. For the recording of the spectra the potassium bromide disc technique has been used, and the suitability of the method for the substances concerned is discussed.

In addition to a great number of S-benzylthiuronium salts previously described in the literature, the paper gives spectra and melting points of more than 100 salts which have not previously been prepared. Further, a description is given of the preparation of the S-benzylthiuronium salts, and the advantage of infrared spectra above melting points for the purpose of identifying the acid concerned is pointed out.

JART, Aa. (Editor): *Infrared Spectra of Carboxylic Acid Derivatives. II. p-Bromophenacyl Esters*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 25, Copenhagen 1963. 65 pp. Sw. Kr. 10:00.

The paper deals with infrared spectra of 141 p-bromophenacyl esters and of p-bromophenacyl bromide and p-bromophenacyl alcohol. The spectra are recorded using the potassium bromide disc technique in the range $625-4000\text{ cm}^{-1}$.

To enable a determination of the purity of the esters a paper chromatographic method has been devised, the purpose of which is to ascertain the presence of any unconverted reagent or hydrolyzed reagent.

In addition, a semi-micro method of preparing p-bromophenacyl esters has been evolved.

A number of the esters dealt with have not previously been described in the literature.

MANNERKOSKI, M.: *On the Decomposition of Austenite in 13 per cent Chromium Steel*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 26, Helsinki 1964, 63 pp, Sw. Kr. 10:00.

A survey of the morphology of microstructures formed in a 0.31 per cent C; 13.9 per cent Cr steel during isothermal decomposition of austenite in the pearlite range, and the kinetics involved. The effects of transformation time and temperature on the microstructures have been discussed, and kinetic laws for grain boundary occupation and volume-transformation have been given.

Metallographic examinations showed carbon depletion ahead of transformation colonies to be considerable, causing divergent pearlite or ferrite with a few grain boundary runners of carbide to form the grain centres. Besides pearlite a periodic granular eutectoid appeared, the proportion of which in entirely transformed structure increased as the transformation temperature fell.

KETTUNEN, P. and FORSTÉN, J.: *Single Crystals Grown by the Bridgman-method in Protective Atmosphere*. Acta Polytechnica Scandinavica, Chemistry Including Metallurgy Series No. 27, Helsinki 1964, 22 pp. Sw. Kr. 10.00.

Single crystals were grown of aluminium-copper, copper and molybdenum-iron by the ordinary Bridgman-method, using either argon or hydrogen as protective gas. Some difficulties were experienced with the argon atmosphere, but these were overcome by careful purification of the gas.

Difference in orientation of the growing copper crystals was effected by changing the maximum temperature and growth rate.

Influence of the impurities in the melted material was observed in three different ways, first of all by the X-ray spots being split at the upper end of the crystal, proving that the impurity concentration there was greater than at the lower end. Secondly, at the upper ends of the oxygen-free-high-conductivity copper crystals, there was found a star pattern figure which was absent in the purer copper crystals. Thirdly, in aluminium crystals there was found a periodic structure of alternating regions of high and low impurity concentration.

However, the results reported here require complementary and more detailed investigation. This is in progress, and will be the subject of a subsequent report.

SULONEN, M. S.: *Contributions to the Theory of Discontinuous Precipitation*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 28, Helsinki 1964, 20 pp. Sw. Kr. 10.00.

A new theory is presented for the driving force of discontinuous precipitation. According to this, the driving force is to be ascribed to the stress energy arising from a steep change in the lattice dimensions of the vanishing matrix in a narrow diffusion zone forming ahead of the cell interface.

To test the theory, the response of the discontinuous precipitation process to external tension has been studied in Cu-Ag, Cu-Mg, Ag-Cu, Pb-Sn and Zn-Cu alloys. It is shown that the directionality appearing in cell interface migration under tension is in agreement with predictions that can be made regarding the interaction of the external and diffusion zone stresses, and thus supports the theory.

KETTUNEN, P.: *The Influence of Grain Size on the Fatigue Behavior of Armco Iron*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 29, Helsinki 1964, 27 pp. Sw. Kr. 10.00.

The fatigue characteristics of a slowly and step-wise cooled Armco iron have been studied at grain diameters varying between approximately 0.01 mm and 1.0 mm.

The slow and step-wise cooling was found to result in the stress vs. number of cycles curve becoming smooth.

The fatigue strength was found to decrease with increasing grain-size, and the diminution obeys the relationship to $d^{-1/4}$. However, this rule is valid only at grain diameters less than 0.1 mm. At this grain diameter, the endurance limit ceases to drop, and remains subsequently constant as the grain-size increases.

The function between fatigue life (i. e. the number cycles corresponding to fracture) and grain-size at different stress levels is found to be represented by an equation given in the paper.

The phenomenon that a grain diameter of about 0.1 mm is critical for the entire fatigue behaviour is thought to be ascribable to the difference in influence exercised by grain boundaries below and above this critical grain diameter. At smaller grain diameters, the grain boundaries are thought to affect the primary slip band formation, but at larger grain diameters, first the development of the formed slip bands towards ultimate fracture.

LAURILA, E.: *A new instrument for determination of the magnetite content of powdered samples*. Chemistry Including Metallurgy Series No. 30, Acta Polytechnica Scandinavica. Helsinki 1964, 19 pp. Sw. Kr. 10.00.

A description is given of the design and construction of a new instrument for determination of the magnetite content of powdered samples. The instrument is based on the principle of the Curie-magnetometer. After the sample, about 2 g in size and contained in a small test tube, has been weighed electrically, a constant-gradient magnetic field is generated around the tube by a movable permanent magnet. The field strength is sufficiently high to bring the magnetization in the sample to saturation. The attraction force is weighed electrically. The output is directly readable as a percentage on the scale of a potentiometer. The practical accuracy is about 0.5 per cent. The instrument is 24 in. x 14 x 12 in. in dimensions, and weighs 100 lb.

KLEMOLA, A. and NYMAN, G. A.: *Condensation of δ -hydroxyvaleraldehyde with formaldehyde. Part I: Preparation of 2,2-bishydroxymethyl-1,5-pentandiol*. Acta Polytechnica Scandinavica, Chemistry Including Metallurgy Series No. 31, Helsinki 1964, 16 pp. Sw. Kr. 10.00.

On comparison of a number of conventional methods for the preparation of δ -hydroxyvaleraldehyde, it was found that by the substitution of a strong acidic catalyst in the hydration of dihydropyran with a weak acid, the yield of δ -hydroxyvaleraldehyde could be raised to more than 90 per cent of the theoretical figure.

In alkaline condensation between δ -hydroxyvaleraldehyde and formaldehyde, the yield of 2,2-bishydroxymethyl-1,5-pentandiol is greatly diminished as a result of the acetal reactions between 2,2-bishydroxymethyl-1,5-pentandiol and formaldehyde. The acetals are destroyed by the hydrogenation of the reaction mixture after condensation. A moderate excess of formaldehyde and dilution of the reaction mixture favour good yields of 2,2-bishydroxymethyl-1,5-pentandiol. The best yield achieved in the synthesis carried out was 75 per cent of the theoretical figure.

The main side reaction in the preparation of 2,2-bishydroxymethyl-1,5-pentandiol is the formation of dimeric products, primarily consisting of compounds with five free hydroxyl groups.

KLEMOLA, A. and NYMAN, G. A.: *Condensation of δ -hydroxyvaleraldehyde with formaldehyde. Part II: 3,3-bishydroxymethyltetrahydropyran-2-ol*. Acta Polytechnica Scandinavica, Chemistry Including Metallurgy Series No. 32, Helsinki 1964, 16 pp. Sw. kr. 10.00.

2,2-bishydroxymethyl- δ -hydroxyvaleraldehyde was synthesized by the condensation of δ -hydroxyvaleraldehyde with formaldehyde under weak alkaline conditions. The infra-red spectrum and reactions of the product, which was separated as a viscous oil, showed that it exists mainly in its cyclic tautomeric form, as 3,3-bishydroxymethyltetrahydropyran-2-ol.

VUORIO, VÄINÖ and KIVALO, PEKKA: *Elimination of the influence of stray capacitances in measurement of the mercury interface capacity*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 33, Helsinki 1964, 17 pp. Sw. kr. 10.00.

The interface differential capacity between a dropping mercury electrode and an aqueous solution of sodium fluoride as a function of the potential has been measured by means of an impedance bridge. The interference of stray capacitances has been eliminated with the aid of two auxiliary capacitors so adjusted that the bridge is in equilibrium not only for a single frequency f , but for a frequency band (f, kf) , where $k > 3$.

By the application of this method, there has been obtained by direct measurement a differential capacity/potential curve for 10^{-2} -c NaF which accurately corresponds to Grahame's semi-theoretical curve calculated from the values measured on 0.916-c NaF. A curve identical with these has been arrived at for 10^{-2} -c NaF by calculation from the values measured for 10^{-1} -c NaF.

RELANDER, K.: *Austenitfall eines 0,18% C - 2% Mo Stahles im Temperaturbereich der Perlitstufe*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 34, Helsinki 1964, 80 pp. Sw. kr. 10.00.

Um die Bildungsmechanismen der in warmfesten normalisierten, mit Cr, Mo und V niedergelegten Stählen auftretenden Sonderkarbide näher zu erläutern, wurde an einem Modellstahl mit 0,18% C und 2% Mo der Austenitfall bei isothermer Umwandlung (800-660° C) und kontinuierlicher Abkühlung verfolgt.

Bei dieser metallographischen Untersuchung (Licht- und Elektronenmikroskopie, Karbidfärbung, Röntgen- und Elektronendiffraktion) erwies sich das einleitend anhand theoretischer Überlegungen aufgestellte freie Energiediagramm und die daraus abzuleitenden Umwandlungsvorgänge, als grundsätzlich richtig.

Eine Ferritbildung leitet die Perlitstufenumwandlung ein. Im C-übersättigten vor-eutektoiden Ferrit gelangen Mo-C-Nadeln zur Ausscheidung. Nach Abbindung des im Ferrit in Übersättigung gebundenen Kohlenstoffs verstärkt sich die Mo-C-Bildung infolge C-Diffusion aus dem Austenit in den Ferrit. Die C-Abgabe des Austenits erlaubt die Bildung von neuem Ferrit. Dieser bisher kaum bekannte eutektoidartige Zerfall - hier semieutektoidale Reaktion benannt - kann ablaufen, bis das Molybdän im Ferrit verbraucht ist. Gleichzeitig entstehen Mo-Karbid/Ferrit Eutektoiden, welche entweder durch periodisch gebildete, etwa parallel der α/γ -Korngrenze stehende Mo-C-Fäden gekennzeichnet sind.

Die Cahn'sche Beziehung für die Zeitabhängigkeit des umgewandelten Volumens $X = 1 - e^{-kt^{1/2}}$ besitzt bis zu relativ hohen X-Werten für die Gesamtumwandlung mit $n = 1,6-1,5$ und für die Eutektoidbildung mit $n = 1,5$ Gültigkeit.

RASTAS, J. AND KIVALO, P.: *Determination by the open-end Capillary Method of the Diffusion Coefficient of Tracers in Electrolytic Solutions*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 35. Helsinki 1964, 20 pp. Sw. kr. 10.00.

This paper deals with the determination by the capillary method of the diffusion coefficient of tracers, and the influence of the sources of error connected with this method, viz. the "immersion effect" and the " Δl -effect", on the test results. A modification of the capillary method is suggested, by means of which continuous registration of the progress of the diffusion is possible; this permits elimination of the influence exercised by the immersion effect on the diffusion coefficient values.

NORDÉN, HARRY V. AND SEPPÄ, ILARI: *A problem on heat conduction in parallel slabs solved by numerical inverse Laplace transform*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy series No. 36, Helsinki 1965, 34 pp. Sw. kr. 10.00.

In this paper a problem on transient heat conduction in parallel slabs is solved. A slab of infinite heat conductivity is bounded by two slabs of a different material with the external surfaces at constant temperature. Generation of heat is taking place in the central slab. The temperature of the central slab is calculated as a function of time.

The differential equations are solved by the Laplace transform. The result function is inverted numerically by a real, numerical inversion formula for the Laplace transform with constant weights and the positive abscissae chosen in geometric progression.

The results are presented graphically and numerically in four significant figures.

ERÄMETSÄ, OLAVI: *Separation of promethium from a natural lanthanon mixture*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 37. Helsinki 1965, 21 pp. Sw. Kr. 10.00.

From 6 000 000 kilograms of apatite 20 000 kilograms of lanthanide oxides have been separated. After repeated dividing into fractions by means of ion-exchange resin a 82 milligram fraction between neodymium and samarium was received. The radioactivity measurements indicated a total amount of $0.9 \cdot 10^{-11}$ grams of Pm^{147} in this fraction. Pm^{147} has most likely been produced from Nd^{146} by means of natural neutron radiation.

KETTUNEN, PENTTI: *Fatigue of copper crystals under reversed constant loading*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 38. Helsinki 1965, 135 pp. Sw. kr. 20.00.

The fatigue of copper crystals was studied by means of material testing and metallography at constant reversed load amplitudes resulting in shear stress amplitudes of or below ± 3.2 kp/mm², which corresponded to fatigue lives of or exceeding 5×10^4 reversals. The stress vs. number of cycles curves arrived at suggest that fatigue life is slightly influenced by the initial orientation of the crystal.

Deformation occurring during different stress cycles suggests that a constant shear stress amplitude capable of causing fatigue fracture results in, during the first quarter of the first stress cycle (tension), a deformation corresponding to a state very high in stage II or to one at the beginning of stage III (of unidirectional deformation).

Metallographic studies suggest that the fatigue occurrence comprises of two stages, the initial hardening and the actual fatigue.

The initial hardening is a period during which the deformation magnitude decreases rapidly until it reaches a minimum. Slip markings and inner dislocation structures show that deformation during this stage is mainly concentrated on the primary slip planes and that deformation resembles that occurring during unidirectional deformation.

The actual fatigue stage brings forward the general characteristics of fatigue. Fracture surfaces in the amplitude range used belong to stage I of Forsyth, but at the highest stress amplitude some small areas resembling stage II were noted.

MIEKK-OJA, H. M., and SILTARI O.: *Heat-treatment of controlled-transformation steels*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 39. Helsinki 1965, 25 pp. Sw. kr. 10.00.

Martensite transformation brought about by means of refrigeration and primary tempering was investigated magnetically in a controlled-transformation steel of the composition 0.08 % C, 16.9 % Cr, 4.15 % Ni, 3.6 % Mn. The M_s -temperature varied from $+6^\circ$ C to -7° C corresponding to solution-heat-treatments at 953° C- 1247° C. Martensite transformation was observed to cease at -50° C with respective quantities of 65 and 45% of martensite in the structure. Such high quantities of martensite, 90%, necessary for optimal yield strength according to Irvine et al., are thus not obtainable by means of refrigeration. Nevertheless, these results may presumably be arrived at by changing the composition of the steel so that M_s rises up to 25° C. By means of primary tempering a more than 90-per-cent-martensite structure could be attained, but due to the low carbon concentration in martensite high values of yield strength could not be reached, and a 90-per-cent-martensite transformation is not easily achieved in commercial practice. In both cases the optimal mechanical properties sensitively depend upon the composition of the steel.

V. SUNDMAN: *A study of lignanolytic soil bacteria with special reference to α -conidendrin decomposition*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 40, Helsinki 1965, 116 pp. Sw. kr. 20.00.

Bacteria that decompose various lignans and which were identified as belonging to the genus *Agrobacterium* were isolated from soil suspensions after serial cultures in a nitrate-mineral medium containing α -conidendrin as sole source of energy. By respirometric, paper chromatographic and spectrophotometric methods the metabolism of lignin-related compounds by these bacteria was investigated.

It was found that cyclolignans are metabolized by a previously unknown path to isovanillic acid.

Olivil and cyclo-olivil are metabolized by a common pathway different from the isovanillic acid path. It was concluded that the bacteria are capable of promoting the interconversion of olivil and cyclo-olivil.

Lignin extracted with alkaline ethanol from brown-rotted wood was slowly oxidized by the agrobacteria.

JART, AAGE: *Infrared Spectra of Carboxylic Acid Derivatives. III. p-Phenylphenacyl Esters and p-Nitrobenzyl Esters*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy series No. 41. Copenhagen 1965, 40 pp. Sw. kr. 10.00.

The article contains infrared spectra of 56 p-phenylphenacyl esters, 20 p-nitrobenzyl esters and of p-phenylphenacyl bromide, p-nitrobenzyl chloride, and p-nitrobenzyl alcohol. The spectra were recorded by means of a Perkin-Elmer Grating Spectrophotometer, model 421, in the range 550-4000 cm^{-1} , using the potassium bromide disc technique.

In connection with this work a number of p-phenylphenacyl esters and p-nitrobenzyl esters were prepared which have not previously been described in the literature. It was found to be possible to correct the melting point values given for various previously described esters. Melting points are given for all the esters dealt with.

With respect to the p-nitrobenzyl esters it is concluded that these esters are inconvenient derivatives for the identification of the carboxylic acids. When p-nitrobenzyl esters of the long-chain fatty acids have to be used, direct esterification is recommended.

JART, AA.: *Infrared Spectra of Carboxylic Acid Derivatives. IV. Amides and Hydrazides*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 42, Copenhagen 1965, 56 pp. Sw. kr. 10.00.

The article contains infrared spectra of 91 carboxylic acid amides, 6 thioamides, and 11 sulfonamides as well as 30 carboxylic acid monohydrazides, and 3 symmetrical dihydrazides. The spectra were recorded by means of a Perkin-Elmer Grating Spectrophotometer, model 421, within the range 550 - 4000 cm^{-1} using the potassium bromide disc technique.

Some of the amides and hydrazides prepared have not been described previously in the literature. Melting points are given for all the compounds considered.

BERG, SØREN: *Determination of Fineness*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy series No. 43, Copenhagen 1965, 30 pp. Sw. kr. 10.00.

The general principles of the fineness analysis are reviewed, and it is pointed out that Andreasen's definition of particle-size permits determination of the average particle-size of a monodisperse fraction by counting and weighing.

Convenient sieving methods, and methods based on a determination by gravitational and centrifugal sedimentation of the change in concentration which takes place at a certain distance from the surface of the suspension, are recommended.

It is emphasized that all sedimentation methods presuppose stable suspensions of individual particles. Therefore many works dealing herewith are referred to.

By graphs an account is given of the influence of diffusion, and it is shown that the lower limits for the measurements by gravitational and centrifugal sedimentation of monodisperse products of density 2.5 are 0.2 μ and 0.005 μ , respectively, and that the limits for heterodisperse products are considerably lower.

A simple expression for the wall effect has been derived and checked by sieving with determination of the particle-size boundary of the sieve.

The accuracy of the methods is demonstrated by comparative measurements.

JART, AA.: *Infrared Spectra of Carboxylic Acid Derivatives. V. Anilides and Substituted Anilides*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No. 44, Copenhagen 1965, 54 pp. Sw. kr. 10.00.

The article contains infrared spectra of 54 carboxylic acid anilides, 9 thiocarboxylic acid anilides, 2 sulfonic acid anilides, 30 carboxylic acid p-toluidides, 1 thiocarboxylic acid p-toluidide, 2 sulfonic acid p-toluidides, 10 carboxylic acid o-fluoroanilides, 9 carboxylic acid m-fluoroanilides, and 11 carboxylic acid p-fluoroanilides. The spectra were recorded using a Perkin-Elmer Grating Spectrophotometer, model 421, within the range $550-4000\text{ cm}^{-1}$ by means of the potassium bromide disc technique.

Some of the derivatives prepared have not been described previously in the literature. Melting points are given for all the anilides and p-toluidides considered.

PIETIKÄINEN, JUHA: *The effect of ageing on the toughness and ductility of martensite*. Acta Polytechnica Scandinavica. Chemistry including Metallurgy Series No 45, Helsinki 1965, 20 pp. Sw. kr. 10.00.

A study has been made of the effects exerted on toughness by the ageing and tempering of martensite in technical carbon, Cr-Si and 13% Cr steels, and of ageing and precipitation annealing in super-saturated ferrite, by means of dilatometric, hardness and torsion impact tests. It was found that:

In martensite the toughness varies as a result of the effect of ageing and tempering. The variations of toughness in ferrite by reason of quench-ageing resemble those brought about in martensite by ageing and tempering. Unaged, or only slightly aged martensite has a high degree of toughness. Martensite becomes brittle when treated within a temperature range at which, according to literature, martensite ages and precipitation begins. The type of precipitated carbide seems to have no significance. As published reports show that the ageing is rapid even at room temperature, the above indicates that the generally observed brittleness of untempered martensitic pieces is attributable to the changes, which occur in the martensite, and not to an inherent property of the martensite structure. The variation in toughness of martensite, i.e. the variation in breaking energy of the test specimens, is primarily attributable to variation in its plastic ductility.

KETTUNEN, P. and RÄSÄNEN E.: *The Influence of Low Temperature Precipitation on the Fatigue Behavior of Armco Iron*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 46, Helsinki 1965, 40 pp. Sw. kr. 10.00.

Low temperature precipitation was found to affect the fatigue behaviour of Armco iron as regards to fatigue strength properties as well as fatigue deformation. Coherent carbides resulted in a smoothly and continuously falling S-N curve, while incoherent carbides produced an ordinary type of S-N curve, with sharp fatigue limit. Endurance limits of these two curves were rather similar, however.

Fatigue deformation at low stress amplitudes was similar in both structures and was found to concentrate to regions, which at the surface appeared as strictly limited slip bands. Thin foil study showed the dislocations to be arranged in tangles containing dipoles. Fracture at low stress amplitudes was always transcrystalline. At high stress amplitudes the fatigue deformation was very much similar to that at low stress amplitudes in the structure containing coherent carbides, but was strongly scattered over the grains in the structure containing incoherent carbides. Dislocations were found to be arranged in tight tangles, but beside these a number of free dislocations appeared between the tangles, too. Fracture in both structures was mostly transcrystalline.

PIETIKÄINEN, J.: *The Effect of Tempering on the Toughness of Hardened Steels*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 47, Helsinki 1966, 80 pp. Sw. kr. 10.00.

The effect of tempering upon the toughness of hardened steel has been investigated. A steel having the nominal analysis: 0.35 % C, 1.5 % Si, 20 % Ni was chosen for this work.

Test bars made of the investigated steel were austenitized and quenched in liquid nitrogen with subsequent isothermal tempering at various temperatures in the range $T_t = -110$ to 450°C . The structures of the heat-treated specimens were examined by X-ray and electron microscopy. The principal part of the work consisted of mechanical tests, for which a torsion testing machine was designed and built. The deformed structures were also examined by electron microscopy. The results seem to indicate the appearance of an as yet unknown carbide when $T_t = 250$ to 375°C . This carbide was found to deform plastically on torsion. With increasing speed of rotation, a discontinuous decrease of total twist occurs with the tempering temperatures 190°C and 310°C . At speeds higher than the critical speed of rotation, work softening occurs in the test bar. Virgin martensite was found to endure considerable plastic deformation at -110°C before fracture occurred. Martensite aged at room temperature was, however completely brittle at -110°C . The rate of work hardening was found to depend on the tempering temperature.

NIEMI, ANTTI: *A Study of Dynamic and Control Properties of Industrial Flotation Processes*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 48, Helsinki 1966, 111 pp. Sw. kr. 20.00.

The transfer properties of industrial continuous flow flotation cells and cell series are studied both in time and frequency domain and appropriate mathematical expressions are derived. Based on these, the simulation and control of flotation are discussed and realizable circuits are suggested. Conditioning in the continuous flow conditioner is studied theoretically and the treatment is extended to cover conditioning with simultaneous flotation in the cells.

The mass flow characteristics of flotation cells have been studied experimentally by means of radioactive tracers. By fitting the results to derived models it is shown that the residence time distribution of the pulp body of the mechanical cell corresponds to that of the perfect mixer in series with a minute plug flow region. For the multiple cell the plug flow region is more pronounced.

As tracer compounds chalcocopyrite, Na_2CO_3 , and solid taling have been used. The problems of representativeness are submitted to a thorough discussion and experimental analysis.

NIEMI, ANTTI: *On the Dynamics of a Pneumatic Flotation Cell*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 49, Helsinki 1966, 39 pp. Sw. kr. 10.00.

This study is based on an earlier study of dynamics of the mechanical flotation cells. The experiments were carried out primarily with the aid of radioactive tracers, using Na_2CO_3 and albite, activated with slow neutrons, as tracer compounds.

For the fluid the dispersion model fits very accurately. The use of single characteristic numbers, like variance, is criticized. Considerable deviations from the theoretical models used are noted for the solids, except for the finest size ranges.

Studies of the distribution of the rate coefficient are based on measurements of the stationary concentrate flow at several points at the cell edge. Few values can be solved for, and hence an unambiguous dependence of the values of the coefficients on the properties of the particle types cannot be presented.

RASTAS, JUSSI: *Ueber die Tracerdiffusion in wässrigen Elektrolytlösungen vom Standpunkt der Thermodynamik der irreversiblen Prozesse.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 46, Helsinki 1966, 37 pp, Sw. kr. 10.00.

Die Tracerdiffusion in wässrigen Elektrolytlösungen ist mittels den Methoden der Thermodynamik der irreversiblen Prozesse behandelt worden. Dabei wurde durchgehend der Begriff des ionischen Bestands beibehalten. Der Formalismus ist dann von Dissoziations- und Assoziationsgleichgewichten unabhängig.

Als Arbeitshypothese wurde für den Konzentrationsverlauf der Onsager'schen Koeffizienten L_{ij} ein Ansatz aufgestellt. Die Grenzwerte von Onsager und Fuoss sind als Grenzanganten-Gleichungen in die Darstellung einbezogen worden, mit deren Hilfe die ersten Koeffizienten in den Reihen der Glieder L_{ij}/c bestimmt wurden.

Aus den ternären Tracerdiffusionssystemen sind die Selbstdiffusionssysteme besonders hervorgehoben worden. Die messbaren Größen derselben wurden denen des entsprechenden binären Grundsystems gegenübergestellt. Es wurden dann die Beziehungen zwischen diesen Größen in hochverdünnten Lösungen dargestellt. Ein Teil der gewonnenen Resultate ist mit Hilfe von Literaturdaten aus den Systemen NaCl, $^{22}\text{NaCl}$, H_2O ; NaCl, Na^{24}Cl , H_2O und NaCl, H_2O überprüft worden.

Mit Hilfe dieser Methoden lassen sich die isothermen Transportprozesse in Tracerdiffusionssystemen einheitlich behandeln, und ihre Eigenschaften können einerseits denen der allgemeinen ternären und andererseits denen der binären Systeme gegenübergestellt werden.

Ch 51

UDC 669.15'24'779-194.56+552.61.062

BUCHWALD, V. F.: *The Iron-Nickel-Phosphorous System and the Structure of Iron Meteorites.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 51, Copenhagen 1966, 46 pp, Sw. kr. 10.00.

From alloys fabricated by powdermetallurgical methods the Fe-Ni-P ternary system has been revised; the results are presented as isothermal sections at temperatures between 1100° C and 350° C. The lattice parameter for the iron-nickel-phosphide has been determined and it is shown that its nickel content increases much as the equilibrium temperature is lowered.

Hardness values are given for quenched and tempered alloys. The austenitic Fe-Ni-P alloys show a remarkable precipitation hardening. It is suggested that prolonged heat-treatments at 350° C give rise to an order-hardening reaction to Fe₃Ni.

It is proposed that the Widmanstätten structure in octahedrites is a result of the two step reaction $\gamma \rightarrow \delta + \epsilon \rightarrow \delta + \gamma$. The structure of the following meteorites is discussed: Tombigbee, Blachfö, Cape York, Roebourne, Ruff's Mt., Marshall Co., Canyon Diablo, Thule, Föllinge, Kokomo, N'Goureyima, Zacatecas and others.

Certain microstructures as plesite, rhodite, heataltered rim, and precipitated phosphides in stressed areas have been synthesized in the laboratory.

Ch 52

UDC 661.634.094.6

DAHLGREN, SVEN-ERIC: *Manufacture of 40-45 per cent P₂O₅ phosphoric acid by the semihydrate process.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 52, Stockholm 1966, 32 pp, Sw. kr. 10.00.

The influence of different process variables on reaction efficiency and filtration were studied using Kfouribga phosphate rock. The different factors limiting the existence region of the semihydrate process are discussed. From this, some general conclusions are drawn regarding the dihydrate and anhydrite processes and their limiting factors. Evidently an inactivation of the semihydrate occurs at moderate and low sulfuric acid excess during acidulation, caused by over-growth of calcium fluoride. At sufficiently high sulfuric acid excess inactivation does not occur. The experience from full scale production is given as well as a description of the plant equipment. Comparison is made with plant experience from the anhydrite process with batch-wise reactor charging. The rubber belt filter was superior in comparison to the travelling pan filter.

ENKVIST, T., MAJANI, C., and TYLLI, T.: *Studies on the Fractionation of Alkali Lignins*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 53, Helsinki 1966, 47 pp, Sw. kr. 10.00.

Commercial kraft softwood lignins and lignins from 2-step alkaline digestions of spruce wood were fractionated with organic solvent. Gel filtration on Sephadex columns, infrared and ultraviolet spectra, and acidimetric titrations make it probable that unconjugated carboxyl and carbonyl groups in particular, and possibly stilbene groups as well, are enriched in the fractions most easily soluble in organic solvents. An "ether insoluble" fraction of kraft lignin seems to contain more phenolic α -aryl carbonyl groups, and possibly also phenolic biphenyl or double bond groups, than do the "ether soluble" fractions. The soda lignins, especially that from the 160° stage, are less soluble in organic solvents, and thus probably more condensed than the kraft lignins. Digestion with sodium hydroxide, especially at 160°, seems in particular to diminish the absorption of lignin preparations which probably is due to some CH-bonds in the side chain.

SCHÜCKHER, F.: *Grain Size*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 54, Stockholm 1966, 102 pp. Sw. kr. 20,00.

Grain size is a special branch of space filling aggregates in quantitative metallography.

Theoretical considerations, practical results and a limited review of the literature are the bases of studies in this topic, with uniform equiaxed grains in single phase metals as the framework.

The statistics of grain size distributions in one-, two-, and three dimensions are discussed, and theoretical solutions compared with experimentally determined results. The log normal distribution has been confirmed and physically explained. The calculation of three dimensional grain size has been somewhat improved and accomplished under the assumption of both spherical and space filling shapes, which have been shown to differ by a correction factor.

The correlation with the physical and chemical properties of a metal and practical simplicity of measurement make the length of linear intercepts the best definition of "grain size".

The measurement of grain size by planimetric, counting, and comparison methods is quoted. Methods which combine counting of planes and intercepts on slip planes are critically discussed and a simple equation for application on space filling aggregates is presented.

Finally some spherical cases of grain size measurement, such as those applied to non equiaxed grains and non uniform structures are enumerated.

LIUKKONEN, S., RASTAS J., HASSINEN, E., and KIVALO, P.: *Eine Modifikation der offenen Kapillarenmethode nach Thomas zur Bestimmung des Tracerdiffusionskoeffizienten in wässrigen Elektrolytlösungen*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 55, Helsinki 1966, 17 pp, Sw. kr. 10.00.

Es wird zur Bestimmung von Tracerdiffusionskoeffizienten in Elektrolytlösungen eine Modifikation der gewöhnlichen Kapillarenmethode dargestellt, in der auf das offene Ende der Kapillare eine dünne Membran aufgesetzt und derart der ΔI -Effekt beseitigt wird.

Die Lösung der Diffusionsgleichung wird mit willkürlicher Anfangsverteilung des Tracers ausgeführt und verschiedene Möglichkeiten zur Bestimmung des von der Membran eingeführten Parameters werden angegeben.

Bei den Messungen wurde eine kontinuierlich registrierende Methode benutzt.

FISCHMEISTER, H.: *Scanning Methods in Quantitative Metallography*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 56, Stockholm 1966, 50 pp. Sw. kr. 10.00.

Apparatus for the quantitative evaluation of microstructures is reviewed with regard to principles of operation and special possibilities as well as shortcomings particular to each. Optimum working procedures and choice of equipment for typical experimental situations are discussed. The scope of the paper extends from simple "manual" counting operations to the wholly automatic analysis of micrographs by automatic scanning machines.

SARKIO, P. and NYMAN, G. A.: *The polymerization of 2,3-dihydropyrane by triethylaluminum-titanium tetrachloride catalysts*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 57, Helsinki 1967, 19 pp. Sw. kr. 10.00.

A study has been made of the effects exerted by the conditions in polymerization. It has been proved that the fixed polymer consists of hydroxyl groups, of which the origin is explicable by the ring opening alone. Toluene-2,4-diisocyanate can be added to the hydroxyl groups; the polymer then changes into an insoluble form which decomposes at about 280°C. The polymer oxidizes quite easily in air, and aldehyde groups result.

LINDFORS, TOR and ENKVIST, TERJE: *Experiments in the synthesis of anion and cation exchangers*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 58, Helsinki 1967, 18 pp. Sw. kr. 10.00.

A series of anion and cation exchangers have been prepared by the application of very simple procedures at normal pressure, and at a temperature not exceeding 100°C. The highest capacities achieved (5.8-8.0 meq./g) were in respect of preparations made with tetraethylene pentamine as the basic, and p-xylylene dichloride or epichlorohydrin as the linking component. The use of polyethylene imine A instead of tetraethylene pentamine gave slightly inferior results. A combination of tetraethylene pentamine, formaldehyde and p-p'-diphenylmethane (bis-phenol) yielded a capacity of 5.2 meq./g. A high yield of an anion exchanger, 5.0 meq./g in capacity, was obtained by a combination of tetraethylene pentamine, p-xylylene dichloride, furfural and phenol. One of moderate yield, capacity 6.0 meq./g, and good capacity for the purification of water (reduction in the permanganate number of water samples) resulted from the combination of tetraethylene pentamine, p-xylylene dichloride, phenol and urea. The admixture of benzylated kraft lignin to tetraethylene pentamine and p-xylylene dichloride appears to yield comparatively high capacities (5.0-5.4 meq./g), combined with good yield.

LINDFORS, TOR, ENKVIST, TERJE, and KIVALO, PEKKA: *Experiments in the preparation of ion exchange membranes for electro-dialysis*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 59, Helsinki 1967, 19 pp. Sw. kr. 10.00.

In a study of some types of anion exchanger membranes, the most promising proved to be those in which the exchanger substance had been synthesized from tetraethylene pentamine, phenol, furfural and p-xylylene dichloride, or from the two first named reagents and epichlorohydrin, with viscose regenerate as the fibre material. The types of membrane based on epichlorohydrin seem somewhat less brittle and more resistant on heating at 145°. Cation exchanger membranes of promising qualities could also be prepared by means of potassium salt of phenoldisulphonic acids, formaldehyde, and resorcinol or m-cresol as starting materials, and viscose regenerate as the fibre material. Further study of the mechanical strength and durability of the membranes is necessary.

NELSON, RICHARD P.: *Interdiffusion studies in the system α -Al₂O₃-Cr₂O₃*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 60, Stockholm 1967, 31 pp. Sw. kr. 10.00.

The applicability of electron microbeam probe analysis to ceramic oxide systems was investigated by measuring the interdiffusion of α -Al₂O₃ and Cr₂O₃. By careful control of experimental procedure, accurate measurement of concentration profiles in the range 20–50 μ m was possible. Concentration dependent diffusion coefficients were calculated from the measured profiles using the Boltzmann-Matano method. Diffusion coefficients varied from 10^{-14} to 10^{-10} cm² sec⁻¹ over the temperature and composition ranges. The activation energy varied from 94 to 111 kcal mole⁻¹ over the range of composition but the variation was within the accuracy of measurement. Although the interdiffusion coefficient increases with the Cr₂O₃ concentration, the actual concentration dependence is represented by a linear increase of D with Al₂O₃ concentration and an exponential increase with the Cr₂O₃ concentration. It is suggested that the energy for the formation of Schottky defects in α -Al₂O₃ is less than the corresponding energy for Cr₂O₃, and that the activation energy for mobility exhibits a linear decrease with increasing Cr₂O₃ concentration.

EASTERLING, KENNETH: *The nucleation of martensite in precipitates of iron in a copper matrix*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 61, Helsinki 1967, 66 pp. Sw. kr. 10.00.

The Fe $\gamma \rightarrow \alpha'$ martensitic transformation of small defectless precipitates of γ -iron in a matrix of copper is studied by thin foil electron microscopy and magnetic measurements. The transformation, which can only be induced by cold working, is found to proceed by the formation and growth of disks of martensite which are nucleated by matrix dislocations passing through the precipitates during the working operation. It is established, however, that martensite can only be nucleated if the stress conditions induced assist the volumetric dilatation, which accompanies the martensitic transformation and mainly occurs perpendicular to the plane of the disks. This result is thus in agreement with work carried out by PATEL and COHEN, 1953, on bulk materials.

LAGNEBORG, R.: *Yielding and fracture of Fe-30 % Cr alloys subjected to 475°C-embrittlement*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 62, Stockholm 1967, 40 pp. Sw. kr. 10.00.

The 475°C-embrittlement has been studied in two Fe-Cr alloys, one Fe-30 % Cr and one Fe-30 %Cr-0.8 %Ti alloy. Yield and fracture stress were determined at room temperature for various grain sizes and after aging at 475°C for times up to 1000 hr. The fracture stress- $d^{-1/2}$ curve (d is the grain diameter) displays a characteristic bend, with one branch with a large slope and approximately extrapolating to a zero stress intercept for large grain sizes and one branch with a more moderate grain size dependence for small grain sizes. In the embrittled material cracks have been observed to be initiated by twins. Based upon the theory of brittle fracture by Cottrell an expression for the fracture stress has been derived for the case when cracks are initiated by twinning. This equation is suggested to account for the experimental fracture stresses at large grain sizes. The ultimate cause for the brittleness is the age-hardening due to the fine precipitation taking place around 475°C. This rise in yield stress will promote brittleness directly, but also indirectly through the enhanced twinning which will increase the tendency for crack initiation.

NIELSEN, JØRGEN ILUM and VEIBEL, STIG: *The reactivity of lactic acid and some of its simple derivatives, a review*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 63, Copenhagen 1967, 64 pp. Sw. kr. 10.00.

The literature dealing with the reactivity of lactic acid and some of its simple derivatives is thoroughly reviewed. Not only reactions in which the functional groups -COOH and -OH are involved are mentioned. Also reactions in which a reactivity of the methyl group is enforced by the reaction conditions are described, and possible mechanisms for such reactions are discussed.

Some industrial applications of polylactic esters are mentioned.

PENTTILÄ, ANERI: *On the biosynthesis of Dryopteris acylphloroglucinols*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 64, Helsinki 1967, 73 pp. Sw. kr. 10.00.

The radioactive labeling method is used to study the biosynthesis of methylene-bis-acylphloroglucinols with live specimens of *D. marginata* as test material.

The methods of synthesis and incorporation of labeled precursors as well as isolation and degradation of labeled metabolites are described.

The results indicate that butyric acid is the source of the butyryl side chains. C- and O-methyl groups are derived from methionine, which also is the source of the methylene bridge via oxidation of a methyl group. The intermediacy of quinone methides in this process is proposed.

Monomers containing both a free ring position and an oxidizable methyl group are incorporated either via anion formation or via oxidation. The former, when possible, is the preferred process. Methylations are shown to occur after ring formation, C-methylation taking precedence over O-methylation. Neither C- nor O-demethylations are important processes *in vivo*. Peroxidase-catalyzed reactions *in vitro* between appropriate oxidizable and nucleophilic monomers yield the naturally occurring dimers.

KALLSTRÖM, O. KRISTER: *Carbon strengthening of martensite in relation to thermally activated deformation*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 65, Stockholm 1967, 26 pp. Sw. kr. 10.00.

The flow stress of iron-carbon martensite, both as untempered and tempered, is measured in compression as a function of temperature and strain rate, and the activation energy of the deformation is calculated according to a technique developed by Conrad. From a comparison with his results on ferrite it is concluded, that Peterls-Nabarro-barriers are thermal obstacles in well tempered martensite as well as in ferrite. In untempered martensite the activation energy is considerably lower, and it is argued that here the thermal obstacles consist of single carbon interstitials. At room temperature thermal fluctuations will fully assist the dislocations in overcoming these obstacles and consequently, single interstitials will have no effect on the flow stress at this temperature. Instead the dominant part of the flow stress at room temperature is considered to be due to athermal obstacles which are thought to consist of couples and larger groups of carbon atoms on adjacent lattice sites. Such obstacles would explain the dependence of flow stress on carbon concentration.

LIDSTRÖM, L.: *Amine flotation of ore minerals and silicates*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 66, Stockholm 1967, 112 pp. Sw. kr. 20.00.

The theoretical background to the adsorption of amines to the minerals of heavy metals, to quartz and to silicate minerals has been studied by potentiometric titration. This study has shown that the reaction between amine reagent and metallic ion takes place through the formation of a complex of the free amine molecule with the metallic ion at a relatively high pH. The reaction between amine reagent and silicate proved to consist mainly in the formation of a bond between aminium ion and silicate ion. Flotation experiments with sulfide minerals confirmed the above reactions, the best results being obtained at pH 10-11. The flotation experiments with quartz and silicates revealed that the amine reagent could float all the minerals studied, but that these show great differences among themselves. The optimum pH is usually between 6 and 8. There is a clear correlation between the silicate grade of the mineral and the flotation capacity; the higher the silicate grade, the better the mineral floats. The reaction between the silicates and the flotation reagents is complicated by the formation of an amorphous gel layer on the mineral surface when the minerals are wet-ground.

JERNQVIST, Å.: *Lamella thickening — and attempt to a theoretical analysis*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 67, Stockholm 1967, 28 pp. Sw. kr. 10.00.

Theoretical analysis for determination of the maximum capacity and the concentration distribution for a lamella apparatus used for lamella thickening (sedimentation of slurries with fairly high concentration of solid particles). The theory is based upon the assumption that the settling rate is a function of solely the concentration (which, at least in low concentration areas, requires a fairly homogeneous size of the particles) and that the lamella is ideal, i.e. that the layer thickness of the clear solution at the upper lamella surface and that of the dense slurry at the lower lamella surface are negligible.

Graphical calculation methods with the help of the "solid flux curve" (solid flux as a function of the concentration of solid particles) are given. Lamella thickening is shown to be a special case of vertical thickening. An interesting result is that the "critical" concentration increases towards the bottom of the lamella apparatus while it theoretically is constant in the vertical thickener.

KETTUNEN, PENTTI O.: *Electrolytic polishing of copper*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 68, Helsinki 1967, 31 pp. Sw. kr. 10.00.

When practical conditions of electrolytic polishing are chosen for electron microscopical preparation, the following points are worthy of attention: Stirring of the electrolyte in relation to the anode is practical because it enables the temperature of the polished surface to be controlled and the current density to be regulated to some extent.

Small changes in the initial copper ion content of the electrolyte have only minor effects on the polishing conditions.

The temperature of the electrolyte is the variable by which the polishing rate can be regulated most effectively. When high polishing rates are required the temperature can be rather high, i.e. near room temperature, but if low polishing rates are required the temperature must be reduced. The current density and thus also the quantity of copper to be dissolved can be regulated by means of the temperature in the temperature range $+20^{\circ}\text{C}$ to -40°C by factor ten.

Preferential attack seems to be rather difficult to avoid if lacquering is used.

Ch 69 I

UDC 620.198:53.082.75

LIND, S. E.: *The pulse polarizer and its use in corrosion research. Literature survey*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 69 part I, Stockholm 1967. 40 pp. Sw. kr. 10.00.

The following method has been used in a number of investigations of electrochemical processes. By means of a pulse generator an electric pulse of short duration is applied to the working electrode, which becomes polarized. The shape, distortion and time dependence of the pulse and the effect of the composition of the electrolyte and addition of corrosion inhibitors are studied. This method has been applied to electrochemical kinetics, the corrosion of metals and the protective efficiency of different coatings and corrosion inhibitors, i.e. both to systems under anodic and under cathodic control. The pulse polarizer is one form of this method. The method is one of the few electrochemical techniques used for testing temporary corrosion preventives. It has some disadvantages, for example, the high current densities used during the measurement may cause partial oxidation of the metal surface and chemical changes and accelerated breakdown of the protective coatings under examination, and it involves the use of an applied pulse of undefined form and size. These considerations and the rather few published articles on the method show that its possibilities are not yet fully developed.

Ch 69 II

UDC 620.198:53.082.75

LIND, S. E.: *The dynamic condenser method in contact and surface potential measurements in studies of surface chemistry and corrosion. Literature survey*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 69 part II, Stockholm 1967. 40 pp. Sw. kr. 10.00.

The principle of using a condenser for the purpose of studying different processes at surfaces by measurement of the contact potential or surface potential was used about a hundred years ago. Zisman has modified this method by using a condenser in which one plate is in continuous vibration during the measurement. This method has been applied in some hundred investigations in surface chemistry and related fields. The results from studies of atmospheric corrosion, evaluation of protective coatings and sorption of gases from the atmosphere or of solutes from solution have given interesting information about these processes. This article, which is based on an earlier report from the Research Institute of National Defence, reviews the theory and construction of the apparatus and some investigations of special relevance to corrosion science.

TIKKANEN, M. H. and TUOMINEN, T.: *On the anodic behaviour of cobalt*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 70, Helsinki 1968, 22 pp. Sw. kr. 10.00.

The electrochemical behaviour of cobalt has been studied both in acidic and alkaline solutions by means of potentiokinetic, galvanostatic, and potentiometric measurements. It is shown that the mechanism of the active dissolution of cobalt is the same as that of iron both in acidic and alkaline solutions. The rate determining step of the dissolution process is the reaction $(\text{CoOH})_{\text{ads}} \rightarrow (\text{CoOH})^+ + e^-$ in both acidic and alkaline solutions. The potentiokinetic polarization curves show three distinct maxima which probably represent the equilibrium reactions Co/CoO and/or $\text{Co}/\text{Co}(\text{OH})_2$, $\text{CoO}/\text{Co}_2\text{O}_3$ and $\text{Co}_2\text{O}_3/\text{Co}(\text{OH})_2$ and/or $\text{Co}(\text{OH})_2/\text{Co}(\text{OH})_3$, respectively.

PIETIKÄINEN, JUHA: *Zero change in length at the hardening and austempering of steel*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 71, Helsinki 1968, 30 pp. Sw. kr. 10.00.

By the aid of length measurements at room temperature, the changes in length in hypereutectoid low-alloy steel at hardening with associated tempering at 200°C, and in one hypereutectoid and two hypoeutectoid low-alloy steels at austempering, were studied.

It could be observed at hardening that when the relative changes in length with different austenitizing temperatures were plotted over the quenching temperature, the curves had a minimum. Its location and depth depended on the austenitizing temperature and on the rolling direction of the billet processed into test bars. It was moreover noted that the austenitizing-quenching temperature combinations resulting in zero change in length obeyed a certain law.

It could be observed at austempering that when the relative changes in length were plotted over the austempering time, the curves had a minimum. It was noted that the zero change in length state could be achieved by austempering also in hypoeutectoid steels.

JORMALAINEN, TOIVO and PIETIKÄINEN, JUHA. *On the recrystallization of austenite in connection with hot-working in slightly hypoeutectoid carbon steel*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 72, Helsinki 1968, 22 pp. Sw. kr. 10.00.

In experiments involving power hammer forging and in hot torsion tests, the recrystallization of austenite and the grain size produced by recrystallization was studied in slightly hypoeutectoid carbon steel.

It was found that when the working temperature increased from 850 to 950°C the flow resistance and the smallest deformation at which the recrystallization progressed easily both became lower; at 5 % reduction the final grain size produced by recrystallization decreased, at 15 % reduction it remained unchanged, and at 38 % deformation it increased. At 950°C working temperature the same final grain size ensued with all degrees of reduction investigated as was produced with 15 % reduction.

EKLUND, DAN: *Studies of the properties of unbleached sulphite pulp with reference to their influence on the rosin sizing of paper.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 73, Helsinki 1968, 128 pp. Sw. kr. 20.00.

A study has been made of the qualities of sulphite pulp which influence its ability to be sized with fully saponified rosin size and aluminium sulphate. The findings indicated that the sizeability was diminished with decreasing extractives content, but that the distribution of extractives in the pulp was also of importance. Metal ions adsorbed on to pulp improved its sizeability, as did an increase in carbonyl groups and in lignin. It was found that the sizeability was impaired by carboxyl groups. A diminution of the hemicellulose content by alkali extraction increased the sizeability. The fine fraction of a pulp was found to have a greater affinity for rosin size than had the coarse; in all probability this was dependent upon greater specific surface and higher electrokinetic potential. In a study of 32 laboratory cooked pulps, it was found that the lignin content is the pulp factor of major importance to sizeability; a similar result was arrived at in a study of 14 technically cooked, unbleached sulphite pulps.

Ch 74 I

UDC 541.123.31:547.268.13:547.295.4'133
541.183

MANDELL, L. and EKWALL, P.: *The three-component system sodium caprylate — decanol — water. Part I: The phase equilibria at 20°C.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 74 I, Stockholm 1968, 116 pp. Part I—III, 192 pp., Sw. kr. 20.00.

The phase equilibria in the three-component system sodium caprylate -- *n*-decanol — water has been investigated at 20°C.

In the system occur two solution phases, five mesomorphous phases and solid phases. Separation of the phases was effected by centrifugation. The composition of the separated phases was determined by analysis and their internal structure by X-ray diffraction measurements. Their consistency and gross appearance were examined and their texture was observed under the polarizing microscope.

The system investigated constitutes a model system for a large number of other three-component systems consisting of water and two amphiphilic substances.

Ch 74 II

UDC 541.123.31:547.268.13:547.295.4'133
541.183

MANDELL, L., FONTELL, K., LEHTINEN, H. and EKWALL, P.: *The three-component system sodium caprylate — decanol — water. Part II: Densities of the various phases and the partial specific volumes of the components.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 74 II, Stockholm 1968, 20 pp. Part I—III, 192 pp., Sw. kr. 20.00.

The density has been determined in the regions of existence of the homogeneous phases in the ternary system sodium caprylate — decanol — water at 20°C. The partial specific volumes of water, decanol and sodium caprylate and of the amphiphilic mixture in various parts of the phases have been calculated from the experimental findings. The study shows that the phases differ from each other with respect to these dimensions. Among other things, the packing in the amphiphile aggregates is denser for the lamellar than for the two-dimensional hexagonal mesophases, while the partial specific volume of water is lower in the latter than in the former phases. Density measurements can thus be used for characterizing a phase in order to distinguish it from another. Knowledge of the partial specific volume of the water and the amphiphilic mixture is needed for the calculation of the internal structure of the mesophases from X-ray diffraction findings.

FONTELL, K., MANDELL, L., LEHTINEN, H. and EKWALL, P.: *The three-component system sodium caprylate — decanol — water. Part III: The structure of the mesophases.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 74 III, Stockholm 1968, 56 pp. Part I—III, 192 pp., Sw. kr. 20.00.

The paper presents the experimental findings from an X-ray diffraction study of the five mesophases in the system sodium caprylate — *n*-decanol — water, two of which display two-dimensional hexagonal and three linear symmetry. The inner structure of the phases is discussed, on the basis of the presented data and derived dimensions.

The dependence of the extent of the regions of existence of the mesophases on various factors, especially the water content and water bonding, is discussed.

LIDSTRÖM, L.: *Surface and bond-forming properties of quartz and silicate minerals and their application in mineral processing techniques.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 75, Stockholm 1968, 149 pp. Sw. kr. 20.00.

In the grinding of quartz and silicates, surface layers with a disrupted lattice or of a gel-like nature up to 0.15 μm thick are formed on the particle surfaces. These surface layers have been studied and their thickness has been determined by X-ray diffraction and DTA. The reactive, disrupted-lattice surface layer produced by rapid dry grinding absorbs a very large proportion of the grinding energy input. The existence of a water envelope stabilised at the quartz surface has been demonstrated by NMR; its thickness is up to 2 μm . The reaction mechanisms of flotation with amine collectors have been established by potentiometric titration performed directly on the mineral and by flotation experiments, and have been found to obey chemical laws. The electrokinetic potential of quartz at various pH levels has been measured by electrophoresis. The reactivity of freshly ground gangue minerals can be utilised to adsorb large quantities of metal ions from polluted waters. The disrupted-lattice quartz gives rise to silicosis much more rapidly than ordinary quartz, and it also gives higher compressive strength in the manufacture of autoclaved lime-quartz products.

LINDROOS, V. K.: *Small angle boundaries and dynamic recovery in aluminium-magnesium alloys.* Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 76, Helsinki 1968, 53 pp. Sw. kr. 10.00.

Principal aspects to be covered are the formation of small angle boundaries and dynamic recovery which were found to be closely connected. The main emphasis is laid on (i) completion of the discussion of knitting of dislocation networks on several types of forests under different solidification conditions in face-centred cubic crystals, and (ii) the characteristic feature of dynamic recovery, i.e. annihilation of both vacancies and dislocations. Additionally, the advantage of the moiré technique for the study of misorientation as well as misfit across small angle boundaries is introduced. Finally, some remarks are made concerning the validity of the knitting mechanism to explain certain other phenomena, as for example creep and annealing recovery.

SAARINEN, A. V. A.: *Stress-induced stacking faults in alpha Cu-Al alloys*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 77, Helsinki 1968, 85 pp. Sw. kr. 10.

Three factors affecting the extension of a dislocation by an acting stress has been considered. These are: (i) the critical tear stress; (ii) anchoring mechanisms, which prevent the trailing Shockley partial from moving with the leading partial; (iii) splitting of a dislocation. It is concluded that stress-induced stacking faults impede the movement of dislocations in intersecting slip planes.

The thermal annihilation of stacking faults has also been studied. It is suggested that the annihilation of stacking faults is caused by the movement of the unlocked Shockley partial dislocation, or by the nucleation of a new Shockley partial provided the temperature is high enough. In the copper — 7.48 wt-% aluminium alloy aluminium has been observed to segregate into stacking faults during annealing.

Finally it has been shown that the threshold stress, the exceeding of which is causing transcrystalline stress corrosion failure in these alloys under an NH_3 atmosphere, approximately equals the critical tear stress.

RÄTY, R., VALANTI, V. O., RÄSÄNEN, E. and MIEKK-OJA, H. M.: *The occurrence of massive ferrite in the heat affected zones of some welded high-strength structural steels corroding in sea water*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 78, Helsinki 1968, 23 pp. Sw. kr. 10.00.

The heat affected zones of some welded low carbon high manganese steels in which these zones have been found to corrode heavily in sea water (Valanti 1968) were studied in electron microscope. The results indicate that the heavily attacked zones consist predominately of massive ferrite.

FORSTEN, J. and MIEKK-OJA, H. M.: *The growth of a stable solid nucleus in supercooled pure melts*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 79, Helsinki 1968, 25 pp. Sw. kr. 10.00.

The growth process of a nucleus after it surpasses the critical size in a supercooled pure melt is examined by calculating, using a "first approximation" approach, the growth rates on the basis of interface kinetics and free energy considerations. Additionally, the growth retarding effects of the latent heat of fusion liberated during solidification is considered, and an attempt is made to elucidate the dendritic growth in a supercooled pure melt.

IHALAINEN, E. K. and MIEKK-OJA, H. M.: *The rôle of end temperature in the resistance welding of carbon steels*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 80, Helsinki 1968, 20 pp. Sw. kr. 10.00.

The influence of the end temperature of welding on the quality of a resistance welded joint was studied microscopically and by means of mechanical tests in carbon steels with carbon contents from 0.16 % to 1.06 %. Following results were obtained:

- Satisfactory joints with a tensile strength equal to or higher than that of the base metal require an end temperature of 1270°C or more, independently of the carbon content of the steel, when the pressure is 3 kp/cm² and the heating rate 210°C/s.
- Satisfactory joints further require that the end temperature remains 20°C or more below the solidus line.
- The difficulties encountered when resistance welding high carbon steels were found to be caused by the fact that the end temperature of welding has to be kept in an interval as narrow as 50°C, whilst the corresponding interval for low carbon steels is 180°C. The resistance welding process of high carbon steels consequently requires very accurate temperature control.

HAKALEHTO, KAARLO O.: *The behaviour of rock under impulse loads. A study using the Hopkinson split bar method*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 81, Helsinki 1969, 62 pp. Sw. kr. 10.00.

The behaviour of rock during fracture was studied using the Hopkinson split bar method. A maximum limit to the energy which can be transmitted through a rock specimen was found for a compressive pulse of a given shape. This limit is essentially a stress amplitude limit such that higher stresses are not transmitted but result in irreversible rock fracturing and consequent energy loss.

The degree of brittleness of rock was determined by using the attenuation of the first wavefront in a fracturing specimen. The results are quite readily applicable in the field, for instance in the estimation of the crushed zone around a hole in which an explosive charge has been detonated.

LEVANTO, ULLA-MAIJA: *On the precipitation of ammonium polyvanadate*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 82, Helsinki 1969, 36 pp. Sw. kr. 10.00.

Comparatively few studies have been made on ammonium vanadates, especially ammonium polyvanadates, although they are important intermediates in the industrial production of vanadium pentoxide.

The effects of crystallization conditions on the nature and properties of precipitated ammonium polyvanadates were investigated on the laboratory scale. The crystal structures of the precipitates were determined by X-ray diffractionometry.

The purity of an ammonium polyvanadate precipitate depends on the composition of the initial solution, the pH of the solution during the precipitation, and the reaction time. It was found that ammonium polyvanadate contains vanadium cations and that its formula is $(\text{NH}_4)_4(\text{VO}_2)_2\text{V}_{10}\text{O}_{28}$. The analogous sodium compound was prepared and its crystal structure was determined by calculating its unit cell dimensions. It was also established that the compound $\text{V}_2\text{O}_5 \cdot \text{H}_2\text{O}$ has not formed in the conditions reported in the literature; the compound has been ammonium polyvanadate.

BJERLE, I.: *Studies of bonding properties of different foundry sands*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 83, Stockholm 1969, 99 pp. Sw. kr. 10.00.

In the present study the surface properties of the foundry sand components, sand and bentonite have been characterized by means of electron micrographs, surface area and water adsorption determinations, and the bonding strength of the sand mixture through measurements of tensile strength and resonance frequency. It has been established that the strength of the foundry sand mixture is determined by the weakest link in the sand-bentonite-water system. At moisture contents below 0.3 % the sand surface affects the strength of the mixture to some extent. In the moisture range 0.3–1.5 % the strength is determined principally by the bentonite-bentonite joint, and above 1.5 % by the capillary properties of the bentonite. The change in free surface energy of the sand, caused by the adsorption has been calculated by means of Gibbs' adsorption equation and correlated to tensile strength and the square of the resonance frequency, the relations being linear at low moisture contents.

NORDÉN, HARRY V. and SEPPÄ, ILARI: *A transient heat conduction problem in a solid with temperature-dependent thermal properties*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 84, Helsinki 1969, 35 pp. Sw. kr. 10.00.

A steam pipe is surrounded by a material with a square cross-section. From zero time the pipe is heated by saturated steam at constant temperature. The thermal properties of the material and the coefficient of heat transfer to the open air are temperature-dependent.

This transient heat conduction problem is solved by using the Laplace transform and the relaxation method. It is shown how the Laplace transform can be applied, even though the thermal quantities of the problem are temperature-dependent. The temperature field is calculated numerically on an electronic computer and the results are presented both numerically and graphically.

TIKKANEN, M. H. and HYVÄRINEN, O.: *On the passivity of Ni-Cr alloys*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 85, Helsinki 1969, 17 pp. Sw. kr. 10.00.

In the Ni-Cr system there exists in non-oxidizing conditions a critical composition around 14–15 % Cr where the electrochemical behavior of these alloys changes markedly. In more oxidizing conditions this critical composition is changed to 8–9 % Cr in agreement with earlier experimental results. These results show that when predicting the electrochemical behavior according to the electron configuration theory it is necessary to consider the environmental conditions more or less oxidizing.

SANICK, IVAR H. and SJÖSTRÖM, GUNNAR: *Continuous microbiological purification of waste-water from paper and wallboard industries*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No 86, Stockholm 1969, 28 pp. Sw. kr. 10.00.

The fast growing strain of *Coniophora cerebella* called "G" and isolated (I. S.) by ultra sound treatment of a suspension of the original strain of *C. cerebella*, has proved to tolerate extreme environmental conditions. After more than 4 years the "G"-strain has not shown any tendency to degenerate in the presence of other soil microorganisms. Also the sclerotia formed quicker than with the original strain. The sclerotium has been investigated by micro photography of frozen sections. It was found that the *C. cerebella* G grows twice as fast on cross cuts of pine as on cross cuts of common birch. In purification tests of waste-water in the pilot plant the pH rose from 3.8 to 5.9 and from 4.25 to 6.60 after a flow distance of 72 m over bed. The BOD of waste-water after purification and correction for water evaporation dropped from 2150 mg/l to 234 mg/l after a flow distance of 104 m over bed. The corresponding drop in COD was from 5590 mg/l to 517 mg/l. The percentage of suspended fibres (turbidity) in waste-water after flowing a distance of 72 m over bed dropped to 47 and to 33.3 per cent of the original.

Ch 87 (1)

UDC 620.197

620.199

FAJERS, C-M., HOLMLUND, L. and STENMAN, E.: *On steam corrosion and steam corrosion inhibition. 1. Amount of cyclohexylamine necessary for complete corrosion inhibition during high pressure autoclaving when different large surface areas of carbon steel are exposed*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 87 (1), Stockholm 1969. Part 1 and 2, 18 pp. Sw.kr. 10.00.

Corrosion experiments have been performed in an autoclave during sterilization of carbon steel materials at 135–140° C for 25 min. The total surface area of the sample batches was varied while the amount of corrosion inhibitor (cyclohexylamine) was kept constant. The autoclave feed water consisted of 500 ml de-ionised water to which 0.45 ml cyclohexylamine was added, i.e. a concentration about equal to the minimum boundary value for complete corrosion inhibition with a constant and small sample surface area.

The investigation showed that no quantitatively measurable corrosion occurred even when the test surface area was increased ca 75 and 150 times.

Ch 87 (2)

UDC 620.197

620.199

FAJERS, C-M. and HOLMLUND, L.: *On steam corrosion and steam corrosion inhibition. 2. Some experiments on the permanence of the corrosion protection produced by cyclohexylamine, octadecylamine and morpholine during autoclaving*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 87 (2), Stockholm 1969. Part 1 and 2, 18 pp. Sw.kr. 10.00.

Carbon steel test samples have been autoclaved enclosed in nylon packages with or without a volatile organic amine as corrosion inhibitor. Considerable corrosion was produced in steam alone while the corrosion was negligible when one of the amines cyclohexylamine, morpholine or octadecylamine was added to the packages.

No diminution in corrosion was obtained when test samples, preliminary autoclaved together with cyclohexylamine or morpholine were exposed to a new corrosive attack either by immersing them in re-distilled water at different temperatures or by re-autoclaving them in steam alone.

The corrosion attack during one autoclaving in steam alone was quantitatively as great as when the test samples were immersed in re-distilled water at +4°C for about three weeks.

DIGRE, MARCUS: *Wet autogenous grinding in tumbling mills. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 88, Trondheim 1969, 43 pp. Sw.kr. 10.00.*

The author discusses the mechanisms operative in autogenous grinding. The viewpoints developed are applied to the operational aspect of the process. Cost considerations are discussed briefly.

A bibliography on autogenous and pebble grinding is appended.

HYVÄRINEN, O. and TIKKANEN, M. H.: *On the anodic behaviour of Pb-Ag alloys in sulphuric acid solutions. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 89, Helsinki 1969, 20 pp. Sw.kr. 10.00.*

Pb-Ag alloys (0–2.5 % Ag) were anodized potentiostatically at constant potentials within the oxygen evolution region (1600–1900 mV SCE). The compositions of the anodic films during the anodic treatments were identified by X-ray diffraction measurements. At lower anode potentials (<+1800 mV SCE) the first anodic product was PbSO₄, which after some minutes was substituted by tetragonal PbO. This in turn began to oxidize into β-PbO₂ after a 20–24 hour anodic treatment. At higher anode potentials (>+1800 mV) α-PbO₂ was the dominating anodic product. Silver was found to have a strong polarizing effect on the anodic reactions, increasing the relative amount of β-PbO₂ in the anodic film and broadening its stability region towards higher positive anode potentials.

HILLERT, L. H.: *The effect of alkaline earth fluorides on some oxides of technical importance. A study of phase relations between the fluorides of one of the metals calcium, magnesium, strontium and barium, the corresponding oxide and one or two of the oxides of silicon, aluminium and titanium. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 90, Stockholm 1970, 208 pp + 32 pp. ill. Sw.kr. 30.00.*

In the present investigation samples of different composition have been heat treated at different temperatures. On cooling the crystallized and glassy phases present have been studied by the aid of X-ray diffraction according to Guinier, microscopy in reflected light, microhardness measurements and micro probe analyses. The information made possible the construction of eutectic curves, liquidus isotherms, primary crystallization fields and two-liquid areas in many of the systems. Further the glass formation and the crystallization behaviour of the glasses were established as well as the presence of twelve unknown crystallized phases. Phase diagrams have been proposed for 23 systems i.e.

$\text{CaF}_2\text{--CaO--SiO}_2$	$\text{CaF}_2\text{--SiO}_2$	$\text{MgF}_2\text{--MgO--SiO}_2$	$\text{SrF}_2\text{--SrO--SiO}_2$
$\text{BaF}_2\text{--BaO--SiO}_2$	$\text{CaF}_2\text{--Al}_2\text{O}_3$	$\text{CaF}_2\text{--CaO--Al}_2\text{O}_3$	$\text{CaF}_2\text{--TiO}_2$
$\text{CaF}_2\text{--}(19\% \text{ CaO} + 81\% \text{ TiO}_2)$		$\text{CaF}_2\text{--CaO--TiO}_2$	

PIETIKÄINEN, JUHA: *Some effects of deoxidation on the machinability of quenched and tempered steel*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 91, Helsinki 1970, 21 pp. Sw.kr. 10.00.

This project examined the machinability of steels in tempered martensite conditions deoxidized with both Ca-Si-Al and Ca-Fe-Si and tempered at various temperatures. The cuttings tests observed the proposed ISO format. The tests were carried out by turning with sintered carbide tools. A simple quick-stop device working on gunpowder was designed for the tests.

The cutting tests revealed that the Ca-Si-Al deoxidized steel was better for cutting than the Ca-Fe-Si deoxidized steel in all the tempered martensite structural conditions studied. This better quality only appeared below a certain cutting speed, depending on the tempering temperature. The Ca-Si-Al deoxidized steel showed a distinct wear inhibiting layer formation in the tool. The layer proved to be rich in Al.

HOLAPPA, LAURI E. K.: *Kinetics and mechanism of sulphation of cobalt and nickel oxides*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 92, Helsinki 1970, 57 pp. Sw. kr. 10.00.

Sulphation kinetics were studied by a thermogravimetric technique and chemical analysis. Time, temperature, and SO_2 partial pressure dependences were treated by assuming diffusion-control and sulphation potential as rate determining factors. Using a modified Arrhenius equation, activation energy values were calculated to be 28.1 kcal/mole for CoSO_4 (643—830°C) and 19.3 kcal/mole for NiSO_4 (650—802°C).

The CoSO_4 and NiSO_4 growth mechanism was clarified by a gold marker technique using a microanalyser for detection. The CoO sulphation occurs mainly by the outward diffusion of cobalt ions, resulting in a Co-ion decrease in the oxide; this causes a gradual transformation of CoO to Co_3O_4 . This is in full agreement with the supplementary experiments showing Co_3O_4 to grow on CoO by cobalt ion diffusion outwards. The proposed mechanism for NiSO_4 growth is the outward diffusion of Ni^{2+} and O^{2-} ion pairs.

CARLHEIM-GYLLENSKÖLD, H.: *The penetration of salt and heat into food-stuffs while being cooked*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 93, Stockholm 1970, 83 pp. Sw.kr. 10.00.

Studies have been made of salt content in specimens of meat and hardened gelatine, which have been immersed in salt solutions, as dependent on time and the percentage of salt in the solutions. Several methods have been used in investigating the penetration of salt into food when cooked in water with varying salt contents. Methods of measuring the temperature in meat and other roasted or boiled foods are discussed. Observations have been made of temperature changes in different parts of foodstuffs which were roasted, boiled or fried. Tables, diagrams and instruments have been developed which permit the advance determination of correct times for the cooking of meat, fish and eggs, and also for the warming and chilling of wine. Some experiments with the cooking of soup stock are also reported on.

MARCUSSEN, LIS: *Adsorption Kinetics*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 94, Copenhagen 1970, 137 pp. Sw.kr. 20.00.

The theoretical calculations of the kinetics of adsorption on porous solids are based on a model, which considers a nonlinear adsorption isotherm and simultaneous resistance to mass transfer in the pore system of the solid and in a film surrounding the particle. This model is in close agreement with results from the experiments, which are performed by passing an air stream with constant velocity, humidity and temperature through a single layer of alumina pellets. The adsorption rate is measured by intermittent weighings. Experimental parameters: Gas velocity, humidity and particle radius. Comparison of theory and experiments allows a determination of 1) the effective diffusivity D_{eff} in the pore system, and 2) the gas film resistance as a function of gas velocity. This yields:

$$\begin{aligned} D_{eff} &= 3.6 \cdot 10^{-6} \text{ m}^2/\text{s} \\ jD &= 0.85 \cdot \text{Re}^{-0.5} \end{aligned}$$

ERÄMETSÄ, O., JOHANSSON, A., and SIHVONEN, MARJA-LIISA: *The decomposition of potash feldspar II*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 95, Helsinki 1970, 12 pp. Sw.kr. 10.00.

An attempt has been made here to develop an economical method for the decomposition of potash feldspar.

By adding a small amount of lanthanide oxide to a reaction mixture consisting of potash feldspar, sulphuric acid and a fluorine-containing compound, a much larger proportion of the feldspar was brought into water-soluble form than would have been expected if the reaction with the liberated hydrogen fluoride had proceeded stoichiometrically. In small-scale experiments (10 g batches), up to 80 % of the feldspar was decomposed when lanthanide oxide was added to the mixture against 60 % maximal decomposition without this addition; the stoichiometric decomposition was only 10 %.

Equally high solubilities were obtained without the addition of lanthanide oxide if the reaction mixture was enclosed in tight vessels during the reaction period.

ERÄMETSÄ, OLAVI and MINKKINEN, PENTTI: *Effect of roasting on amblygonite and its dissolubility*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 96, Helsinki 1970, 18 pp. Sw.kr. 10.00.

In this work, an investigation has been made of the effect of roasting on amblygonite, by the application of X-ray diffractometric and thermoanalytical methods. At temperatures above 700°C, amblygonite decomposes into a number of other minerals, of which lithium orthophosphate, lithium aluminate (Li spinel), two forms of aluminium orthophosphate, and two components — obviously aluminium fluophosphate — were identified. The decomposition of amblygonite occurs during two endothermic reactions, with a loss of water and fluorine (the total loss of weight during 1/2 h at 900°C was 4.92 %). More than 95 % of the lithium content of the roasted amblygonite can be leached with diluted sulphuric acid, with only about 15 % of the aluminium content being dissolved. The optimum temperature for the roast was 900°C. The amblygonite samples were taken from the Viitaniemi pegmatite deposit at Eräjärvi, Finland.

CARSTENSEN, P.: *Electron spin resonance studies of free radicals formed in elastomers by ultraviolet irradiation*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 97, Stockholm 1970, 26 pp. Sw.kr. 10.00.

The radicals formed by ultraviolet light from a medium pressure mercury lamp at liquid nitrogen temperatures in poly(isobutene), cis-1,4-poly(isoprene), cis-1,4-poly(butadiene), and cis-1,4-poly(piperylene) are summarized and discussed in relation to bond energies, to end products formed by both high energy and UV irradiation, and to the results from other polymers.

ERÄMETSÄ, O.: *A method for the direct burning of black liquor to white liquor in the sulphate process*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 98, Helsinki 1970, 14 pp., Sw.kr. 10.00.

In this paper, a method is suggested for adjustment of the combustion of black liquor in the sulphate process so that white liquor is obtainable direct. The method, here called carbon monoxide combustion, applies the fact that the equilibrium of the reaction $\text{CO}_2 + \text{C} \rightleftharpoons 2 \text{CO}$ at temperatures exceeding 1000°C is on the side of carbon monoxide.

The reaction kinetics of the combustion method is studied experimentally by the use of a synthetic black liquor composed of 75 % rye grains and 25 % soda.

The heat balance of the suggested combustion method is studied through calorimetric data.

CIVIL ENGINEERING AND BUILDING CONSTRUCTION SERIES

APS CI 1.

UDC 626.01:627.1

BRETTEING, A E, *Stable Channels*. Acta Polytechnica Scandinavica (Acta P. 245/1958), Civil Engineering and Building Construction Series 1, Copenhagen 1958, 130 pp. Sw. Kr. 7:00.

A theoretical study of the form and size of the equilibrium profile formed in a channel with no bed load transport and in a cohesionless material.

Formulae for the dimensions of this profile for given values of discharge, limiting tractive force, friction angle and hydraulic roughness are derived. Especially roughness as in natural watercourses is introduced.

Mean velocity formulae are found and compared with well known empirical formulae.

The relation between degree of fullness, ratio of mean to maximum velocity and relative roughness is established.

The theory is compared with known model tests.

APS CI 2

UDC 624.131.222

OSTERMAN, J, *Notes on the Shearing Resistance of Soft Clays*. Acta Polytechnica Scandinavica (Acta P. 263/1959) Civil Engineering and Building Construction Series 2, Stockholm 1959, 24 pp. Sw. Kr. 7:00.

Mainly in connection with investigations of the risk of landslides in a valley, it proved necessary to make additional research on the strength of soft clays. Some results are reported to encourage discussion.

The results indicate the value of common quick testing and the cohesion method and the difficulties in establishing unique relations between strength and effective stresses because of the secondary settlements and creep.

Moreover, objections to the common way of using the Coulomb formula and of treating triaxial test results are raised, and modified values of the apparent angle of friction are plotted against the plasticity index.

APS CI 3

UDC 624.131.532:624.134.4

EIDE, OVE AND JOHANNESSEN, IVAR J.: *Measurements of Strut Loads in the Excavation for Oslo Technical School*. Acta Polytechnica Scandinavica (Acta P. 266/1960), Civil Engineering and Building Construction Series 3, Trondheim 1960, 14 pp. Sw. Kr. 7:00.

The paper describes the results of strut loads measurements in an excavation in soft clay carried down below the critical depth for bottom heave.

The measurements indicate greater earth pressures than could be calculated from the classical earth pressure theory. The position of the resultant of the observed strut loads is much higher than would be expected from the theory. A redistribution of the earth pressure is believed to account for these deviations.

JOHANNESSEN, IVAR J.: *Test Section and Installation of Test Equipment, Oslo Subway*. Acta Polytechnica Scandinavica (Acta P. 267 I/1960), Civil Engineering and Building Construction Series 4, Trondheim 1960, 8 pp. Sw. Kr. 7:00. (for both part I and II)

In connection with the construction of Oslo Subway, earth pressure measurements were made in a strutted excavation soft silty clay. The article presents a description of the test section, with a summary of soil properties. All the measurements were made in a cross section of the excavation, the excavation being approximately 28 meters long.

On both sides of the excavation earth pressure cells and vibrating wire strain gauges for measuring earth pressure and stresses in the sheet piling, were installed directly on the sheet piles. The struts were equipped with vibrating wire strain gauges for measuring strut loads.

In addition, specially settlement stakes and piezometer points were installed to measure the settlements and changes in pore water pressure during construction. The article describes further the installation of testing equipment, together with a record of the practical experiences obtained. The results of the measurements, and comparisons with calculated values, are given by B. Kjærnsli (1958).

ØIEN, KJELL: *An Earth Pressure Cell for Use on Sheet Piles, Oslo Subway*. Acta Polytechnica Scandinavica (Acta P. 267 II/1960), Civil Engineering and Building Construction Series 4, Trondheim 1960, 8 pp. Sw. Kr. 7:00 (for both part I and II)

The paper describes an extremely robust earth pressure cell, for use on sheet-piles driven into a deposit of soft clay. The operation of the cell depends on the variation in the natural frequency of a steel wire stretched between two arms in a diaphragm, caused by a change of the stress in the wire.

When an external pressure acts on the diaphragm, the stress in the wire increases and accordingly its natural frequency. The frequency is measured by an instrument constructed at the Building Research Station, Watford, England.

The cell is calibrated against water pressure, and the calibration curve is approximately linear, but shows that the cell possesses some degree of hysteresis. The cell is constructed for a maximum pressure of 2.5 kg/cm² and its over-all accuracy is ± 3 per cent of the full load pressure.

KJÆRNSLI, BJÖRN: *Test Results, Oslo Subway*. Acta Polytechnica Scandinavica (Acta P. 268/1960), Civil Engineering and Building Construction Series 5, Trondheim 1960, 11 pp. Sw. Kr. 7:00.

Oslo Subway, which will pass through soft, normally consolidated clay, is partly built in open excavation. At the very first stage of this excavation work, which has been carried out between strutted sheet piles, testing equipment has been installed for the purpose of measuring earth pressure on the sheet piles, stresses in the sheet piles, strut loads, pore pressure and settlements. This paper gives the results obtained up to March, 1958.

The results of the measurements of the earth pressure on the sheet piles, so far obtained, show that the earth pressure is not distributed in accordance with the classical theory. For the stage of the construction when the sheet piles are strutted at one level only, the measured earth pressure distribution seems to be fairly well in accordance with the theory of Brinch Hansen, and the earth pressure measured is fairly well enclosed by the empirical diagram by R. Peck.

KYRKILUND, H.: *Über die Einschätzung von Biegespannungen in gekrümmten Balken*. Acta Polytechnica Scandinavica (Acta P. 274/1960.) Civil Engineering and Building Construction Series 6, Helsinki 1960. 56 pp. + figs. Sw. Kr. 7:00.

Die vorliegende Untersuchung zeigt, dass man die Biegespannungen in gekrümmten Balken mit einer für gewöhnliche Festigkeitsberechnungen vollendes befriedigenden Genauigkeit nach den einfachen, für gerade Stäbe geltenden Formeln einschätzen kann, wenn man die Resultate mit einem Formfaktor α' vergrößert.

$$\alpha' = 1 + \frac{1}{6} \left(\frac{H}{r_1} + \frac{H}{r_m} \right)$$

wo H Höhe des Profils

r_1 Krümmungshalbmesser der innersten Fasern und

r_m Krümmungshalbmesser der Fasern in der Mittellinie des Profils sind.

Für einfache Rechtecke, Trapezte und Dreiecke gilt die Formel an sich, bei aus Rechteckelementen zusammengesetzten Profilen muss das Zweite Glied in Klammer mit dem Völligkeitsfaktor des Profils multipliziert werden. Für Kreise, Ellipsen und Rohrprofile hat man dazu das erste Glied im Klammersdruck um 50 % zu vergrößern, während das zweite Glied 25 % kleiner angesetzt wird.

APS Ci 7

UDC 624.131.436

551.525

VUORELAINE, O.: *Thermal Conditions in the Ground from the Viewpoint of Foundation Work, Heating and Plumbing Installations and Draining*. Acta Polytechnica Scandinavica (Acta P. 277/1960.) Civil Engineering and Building Construction Series 7, Helsinki 1960. 40 pp. Sw. Kr. 7:00. (Also: The State Institute for Technical Research, Finland, Publication no. 51.)

Available information on the soil temperatures at varying depths in terms of the time of the year is rather limited; therefore, the temperatures in the ground have been calculated for three different values of the temperature conductivity for different depths and times of the year, using as a basis the mean value curve of the daily mean temperatures from the ten-year period 1945-1954 in Helsinki ($\varphi = 60^\circ 10'$, $\Psi = 24^\circ 57'$), which are known from meteorological observations. The daily mean temperature of the ground measured at 1 cm depth, is found to follow closely the variations of the daily mean air temperature during the time when there is no snow cover. However, the soil temperatures are higher by 1°C on the average.

Finally, the heat quantity stored in the ground, per unit area in a ground layer extending from the soil surface to 10 m depth, as a function of the time of the year, and the vertical heat flow in the ground have been calculated. The results are compared with measurements carried out by the author and by other investigators.

APS Ci 8

UDC 536.2:697.133:69.025.1

VUORELAINE, O.: *The Temperature Field Produced in the Ground by a Heated Slab Laid Direct on Ground, and the Heat Flow from Slab to Ground*. Acta Polytechnica Scandinavica (Acta P. 278/1960.) Civil Engineering and Building Construction Series 8, Helsinki 1960. 60 pp. Sw. Kr. 7:00. (Also: The State Institute for Technical Research, Finland. Publication No. 52.)

The equations of the temperature field produced in homogeneous ground by a heated floor slab laid direct on the ground and having rectangular shape, the shape of a narrow strip, or circular shape, in the stationary state, have been solved and a study has been made of which boundary conditions give a field and thermal flow best consistent with conditions in actual practice.

The equations for the field produced by a slab having the shape of a narrow strip have also been derived for non-stationary states when the temperature of the slab or the thermal flow passing from the slab to the ground is a function of time, known from measurements. Fourier's and Hankel's transformations have been used in the solutions and the unknown functions occurring in them have been found by a systematic procedure, e.g., as the solutions of dual integral equations.

The results have been graphically presented.

VUORELAINE, O: *The Temperatures under Houses Erected Immediately on the Ground and the Heat Losses from their Foundation Slab*. Acta Polytechnica Scandinavica (Acta P. 289/1960) Civil Engineering and Building Construction Series 9, Helsinki 1960. 105 pp. Sw. Kr. 14:00. (Also: The State Institute for Technical Research, Finland. Publication No. 55.) Finnish Contribution No. 17.

The investigation contains a theoretical treatment of the thermal conditions in the soil under a heated floor slab and of the heat losses from the slab into ground, taking into account the temperature distribution field inherent in the soil. In addition to the theoretical results, the results from measurements carried out in experimental houses, relating to temperature and moisture conditions in the soil and to the heat losses from the slab into ground in the different seasons, are presented. The contribution of the heat losses from the floor structure into ground to the overall heat dissipation can be seen from the thermal energy balance of the house.

Moreover, a method employing tables based on mathematical equations for calculation of the heat losses from floor structures and for dimensioning their thermal lagging has been presented.

GIBSON, R. E. and LO, K. Y.: *A Theory of Consolidation for Soils Exhibiting Secondary Compression*. Acta Polytechnica Scandinavica (Acta P. 296/1961.) Civil Engineering and Building Construction Series 10, Trondheim 1961. 16 pp. Sw. Kr. 7:00. Norwegian Contribution No. 11.

A theory of one-dimensional consolidation taking account of secondary time effects is presented. General expressions for excess pore water pressure and settlement for any type of monotonic time dependent loading have been obtained and these are specialized to the case of step loading.

The parameters involved in the theory are the permeability, the viscosity, and the primary and secondary compressibility of the soil structure. Methods for determining these parameters from laboratory consolidation tests are discussed. Some laboratory test data on three clays: London clay, Grangemouth clay, and Sodium Bentonite are presented which seem to justify the assumptions made in the theory. Finally, the application of the theory to settlement analysis is considered.

ASKEGAARD, Vagn: *Measurements of Pressure between a Rigid Wall and a Compressible Medium by Means of Pressure Cells*. Acta Polytechnica Scandinavica (Acta P. 300/1961.) Civil Engineering and Building Construction Series 11, Copenhagen 1961. 35 pp. Sw. Kr. 7:00. Danish Contribution No. 14.

Three types of pressure cells are assessed. The relation between the deflexion of the front plate and the error in registration of the pressure cell is given as a function of the dimensions of the pressure cell and the physical constants for the cell and for the compressible medium. The latter is assumed to be homogenous and isotropic and to follow Hooke's law.

The following types of pressure distribution between the pressure cell and the compressible medium are considered: uniformly distributed pressure, axially symmetrical pressure distribution, and arbitrary pressure distribution. These pressure distributions refer to the imaginary state in which the deflexions of the front plate are 0 everywhere.

ROSENQVIST, I. Th.: *Subsoil Corrosion of Steel*. Acta Polytechnica Scandinavica (Acta P. 307/1961). Civil Engineering and Building Construction Series No. 12, Oslo 1961, 93 pp. Sw. Kr. 7:00. Norwegian Contribution No. 12.

The increasing use of iron and steel in underground constructions such as pipelines, sheet piling and foundation piles has rendered the problem of subsoil-corrosion most urgent. The chief purpose of this publication is to give potential users of iron and steel the benefit of our present knowledge in this field.

Underground corrosion is treated as a complex of electrochemical processes which can be divided into anodic and cathodic reactions. The importance of the cathodic reactions in determining the rate of corrosion is stressed especially.

The theory of the Norwegian Geotechnical Institute's corrosion probe is given, together with a description of the instrument and its use. This sonde enables prediction of actual corrosion rates in different soils.

Methods of corrosion protection are described, with particular emphasis upon cathodic protection.

SELBERG, Arne: *Oscillation and Aerodynamic Stability of Suspension Bridges*. Acta Polytechnica Scandinavica (Acta P. 308/1961) Civil Engineering and Building Construction Series No. 13, Oslo 1961, 69 pp. Sw. Kr. 7:00. Norwegian Contribution No. 13.

A derivation of formula for frequencies of vertical and torsional oscillations is offered for suspension bridges with 1, 2 or 3 span. Various secondary effects are discussed. Principles for model tests in wind tunnel are given.

Critical wind velocities are defined and non-dimensional diagrams give the bridge designer a possibility for a rapid investigation of the aerodynamic stability of the bridge.

JENSEN, Osmund: *Shallow Hyperbolic Paraboloidal Shells*. Acta Polytechnica Scandinavica (Acta P. 310/1961). Civil Engineering and Building Construction Series No. 14, Trondheim 1961, 19 pp. Sw. Kr. 7:00. Norwegian Contribution No. 14.

This paper deals with the bending theory of shallow hyperbolic paraboloid shell roofs. The solution is obtained in terms of power series, which converges for extremely shallow shells. The method to obtain the solution in the divergent domain is indicated as well.

HELANDER, E.: *Über die Tragfähigkeit eines aussermittig gedrückten aus Streifen zusammengesetzten rechteckigen Pfeilers ohne Zugfestigkeit*. Acta Polytechnica Scandinavica (Acta P. 311/1962) Civil Engineering and Building Construction Series No. 15, Helsinki 1962, 67 pp, Sw. Kr. 7:00. Finnish Contribution No. 28.

In dieser Arbeit wird das Tragvermögen einer gemauerten Wand mit Luftspalten in Mörtelfugen bestimmt. Die Differentialgleichung der Nulllinie wird auf Grund einer von ANGERVO angegebenen Theorie hergeleitet und an Hand der Lösung dieser Gleichung werden die kritischen Spannungen bestimmt. In der theoretischen Betrachtung ist die Wand durch ein im Titel bezeichnetes Modell ersetzt. Gültigkeit des HOOKEschen Gesetzes wird angenommen.

Numerische Ergebnisse werden für Pfeiler mit Mörtelfugen angegeben, die sich aus zwei Streifen gleicher Breite mit einem Spalt von einer Breite gleich $\frac{1}{3}$ bzw. $\frac{1}{2}$ der gesamten Pfeilerdicke zusammensetzen, sowie für Pfeiler mit drei solchen Streifen, wobei die Breite eines jeden Streifens und der beiden Spalte je $\frac{1}{3}$ der Pfeilerdicke beträgt. — Das auf die Nettoquerschnittfläche bezogene Tragvermögen eines aus Streifen zusammengesetzten Pfeilers zeigt sich demjenigen eines Vollpfeilers überlegen; in einigen Fällen kann es auch absolut einen höheren Wert haben.

Ausser den theoretischen Betrachtungen wird auch über die Resultate einer kleinen Versuchsreihe berichtet, und die Ergebnisse stimmen innerhalb der Grenzen der Messgenauigkeit überein.

HELLAN, Kåre: *Application of a Numerical Procedure to the Analysis of Thin Rectangular Plates of Variable Thickness*. Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 16, Trondheim 1963. 20 pp., Sw.Kr. 10:—.

The subject of the present paper is the analysis of thin elastic rectangular plates carrying a transverse load which within certain limitations may be arbitrary. A numerical solution is given for cases of arbitrary thickness variation in the direction parallel to one pair of edges.

ASKEGAARD, Vagn: *Measurement of Pressure in Solids by means of Pressure Cells*. Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 17, Copenhagen 1963. 31 pp., Sw.Kr. 10:—.

Analytical expressions are derived for stress and strain components for two types of inclusions, both shaped like axisymmetric ellipsoids. With slight modifications, these inclusions might be used as pressure cells. The expressions permit; i.e. an estimation of the «transverse sensitivity». One type gives a fairly considerable «transverse sensitivity», if α (ratio between height and diameter) does not correspond to ν (Poisson's ratio for the infinite medium). The reading of the other type can be made accurate at will by making α sufficiently low.

Further, model tests have been carried out with a pressure cell of a shape that is similar, in principle, to that of a type of cell used in practice. The «transverse sensitivity» of this type shows a certain conformity with that of the first mentioned type of inclusion.

RALLIS, TOM: *Terminal Transportation Engineering I, AIRPORTS, An Operational Research Study of the Capacity of Copenhagen Airport Kastrup*. Second Edition. Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 18, Copenhagen 1963, 118 pp., Sw. Kr. 20:00.

The handling of traffic in en-route areas, terminal areas, runway systems, and on aprons as well as inside and outside the terminal building is studied section by section for the purpose of ascertaining the number of service channels, the service time, arrival intervals, and waiting times both now and in future.

VUORELAINE, O.: *A practical method for calculation of the heat losses into the ground from buildings erected immediately on the ground*. Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 19, Helsinki 1963. 51 pp. Sw.Kr. 10:00.

The work presented in this paper is based on three investigations by the author previously published in the same series (Ci 7, Ci 8 and Ci 9). In them the thermal conditions in the ground were considered from the viewpoint of sanitary engineering work, the mathematical foundations for calculation of the heat losses into the ground from buildings erected immediately on the ground were stated, and the results of performed measurements were presented.

In this paper a practical method, including nomographs, is presented for the calculation of the above-mentioned heat losses. At first, the basis of calculation of the nomographs is briefly stated. Nomographs are given for floors having the shape of a narrow strip, for rectangular floors and for circular floors. Moreover, the thermal conductivity of the ground and the thermal conditions in the ground are treated, and the design values to be used in the calculations are presented. By these methods also the heat losses from the individual rooms into the ground can be calculated. The calculations can be carried out either for uninsulated floors or for floors provided with thermal lagging.

ORDING, F. B.: *Unmittelbare Übertragung in rechtwinkligen Gauss-Krügerschen Koordinaten zweier Nachbarstreifen*. Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 20, Trondheim 1963. 00 pp. Sw.Kr. 10:00.

Eine unmittelbare Übertragung in rechtwinkligen Gauss-Krügerschen Koordinaten zweier Nachbarstreifen ist gewöhnlich ziemlich zeitraubend und dazu pädagogisch unbefriedigend weil die Formeln sehr kompliziert sind. Eine Vereinfachung ist jedoch möglich und lässt sich mit einer Genauigkeit von ± 1 cm und ohne umfassende Tafelwerke durchführen.

SEPPALA, V.: *On the calculation of the bearing capacity of an eccentrically loaded straight concrete column with a parabola as its stress-strain curve.* Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 21, Helsinki 1963. 42 pp. Sw.Kr. 10:00.

A calculating method is presented for the determination of the bearing capacity of concrete columns with hinged ends as well as with elastically built-in ends under eccentrically placed load acting in a direction parallel to the axis.

The calculating method has been derived on the foundation of the technical theory of bending and assuming that the stress-strain curve is one of the square parabolas passing through the origin. Concrete has been assumed to be a completely elastic substance and its ability to withstand tension, which is well-known to be minimal, has been neglected.

For various modes of loading and for different stress-strain parabolas, the final results referring to a column with hinged ends have been presented in the form of numerical tables and corresponding graphs. The bearing capacity can be found from the same tables and graphs by means of minor additional computations also when the column has elastically built-in ends, provided that the end moment and the load conform to a given condition.

AFELAND, K.: *Analysis of Bending stresses in Translational Shells including Anisotropic and Inhomogeneous Properties.* Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 22, Trondheim 1963. 164 pp. Sw.Kr. 20:00.

System of equations for bending of in homogeneous, asymmetrically rib-reinforced, orthotropic shallow shells is deduced.

Levy-type solutions for orthotropic translational shells and hyperbolic paraboloids are discussed in detail.

Numerical examples which illustrate the design of rib-reinforced wooden shells are included.

MIKKOLA, MARTTI and YLINEN, ARVO: *Effect of shearing force on the deflection of a beam of finite length on an elastic foundation.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 23, Helsinki 1964, 61 pp. Sw. Kr. 10.00.

In Winkler's elementary theory of a beam on an elastic foundation it is assumed that differential equation (4) of the elastic line conforming to the elementary theory of bending is valid for the deflection of the beam. In this differential equation, the effect of the shearing stresses on the deformations of the beam has not been taken into consideration. The aim of the present study is that of completing differential equation (4) in this respect, and of showing the kind of effect exerted by the shearing stresses on the deflection, the bending moment, and the shearing force of the beam. The effect of the shearing stresses proves to be so substantial in some cases that it is necessary to take it into consideration. This effect depends on the dimensionless parameter a , which formulae (7), (124), (129) and (130) present in different forms. From them it can be concluded that a , and accordingly the effect of the shearing stresses, attains high values when the foundation is hard and the modulus of elasticity of the beam is small, as well as when the height of the beam is great in comparison with its length and breadth. The three examples presented in section 7 illustrate the effect of the shearing stresses.

Ci 24

UDC 532.543.1

ENGELUND, FRANK: *Flow resistance and hydraulic radius*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 24, Copenhagen 1964, 23 pp. Sw. Kr. 10.00.

In section 1 it is shown how the Colebrook-White resistance formula may be substituted by a complete set of practical formulae. In section 2 the effect of the non-uniform shear distribution in open-channel flow is investigated. It has been proved that the traditional concept of hydraulic radius is unsatisfactory and should be replaced with the so-called "resistance radius". An experimental verification is given.

Ci 25

UDC 624.073:539.38

HELLAN, KÅRE: *The Bending of a Ring-Sector Plate with Clamped Circular Edges*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 25, Trondheim 1964, 14 pp. Sv. kr. 10.00.

The bending of a thin elastic plate bounded by two concentric circular arcs and two radial lines is investigated. A solution is given in the form of a simple series of biharmonic functions, each satisfying the prescribed condition of clamping along the circular boundaries. The analysis has resulted in a multi-parameter programme for a digital computer; an example of the application is given. Finally the use of a similar procedure in the corresponding problem of plane stress or strain is briefly indicated.

Ci 26

UDC 624.073:624.012.45

NIELSEN, M. P.: *Limit Analysis of Reinforced Concrete Slabs*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 26, Copenhagen 1964, 167 pp. Sv. kr. 20.00.

This paper represents an attempt to describe the theory of plasticity for reinforced concrete slabs exclusively by means of the theory regarding perfectly plastic materials. Yield conditions are formulated for both isotropic and orthotropic slabs on the basis of plausible assumptions concerning the characteristics of the concrete and the reinforcement. Further, a number of exact solutions for isotropic slabs are given.

The paper also presents a nodal force theory and a number of upperbound solutions containing curved yield lines. Finally, some lower-bound solutions are given, together with a theory for slabs with orthotropic reinforcement, based on the yield condition derived.

ENGELUND, FRANK: *A Practical Approach to Self-preserving Turbulent Flows*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 27, Copenhagen 1964, 28 pp. Sw. kr. 10.00.

Section 1. Self-preserving turbulent boundary layers.

A method based on the concept of eddy viscosity is proposed. It is demonstrated that a constant value of ϵ may be assumed, provided a theoretical slip-velocity U_b is introduced at fixed boundaries. Expressions for ϵ and U_b are proposed and results are compared with experiments.

Section 2. The distribution of velocity and boundary shear in uniform channel flow.

On similar assumptions a general method of calculation has been proposed for uniform flow in shallow channels. The method has been applied to account for the distribution of velocity and boundary shear in channels of shallow triangular and trapezoidal cross sections.

DITLEVSEN, OVE: *Statistical Description of Traffic Loads on Structures*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 28, Copenhagen 1964, 33 pp. Sw. kr. 10.00

When a structure is subjected to a load intensity that varies at random in both space and time, the internal forces and the deflections of the structure also vary at random. These phenomena may be described as realizations of stochastic processes. The most important statistical parameter describing the load is, next to the mean value function, the covariance function. With this function at hand, the covariance function for every linear effect of the load may be calculated by an integration.

In this paper stochastic load models for a number of traffic situations are considered. Special consideration is given to disturbed traffic, i.e. traffic with queues. The covariance function is solution to an integro-difference equation. The solution is obtained immediately in many cases. Numerical procedures must, however, normally be used. Such a procedure has been written in ALGOL for the Danish computer GIER.

FORSBLAD, LARS: *Investigations of internal vibration of concrete*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 29, Stockholm 1965, 32 pp. Sw. kr. 10.00.

A testing method has been devised for determining the radius of action of internal vibrators in fresh concrete. Tests have been made with internal vibrators with varying frequencies, amplitudes, tube diameters, etc. The largest radius of action was obtained at an "optimum" frequency about 12 000 vibr. per min.

The radius of action of an internal vibrator was to a high degree influenced by the consistence and the composition of the concrete, the dimension and design of the form, and the reinforcement.

A number of test specimens were compacted with internal vibrators, working with different frequencies and amplitudes. After hardening 15 cm cubes were sawed from the test specimens. The variations in the compressive strength and in the unit weight of the cubes were found to be small.

JENSSEN, OSMUND: *An Example of how to obtain a nearly Membrane State of Stress in a Shallow Hyperbolic Paraboloidal Shell*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No 30, Trondheim 1965, 18 pp, Sw. kr. 10.00

A roof composed of 4 hyperbolic paraboloidal shells covering a square area is considered. The stiffening beams carrying the compressive forces in the top of the shell have a small slope towards the outer boundaries. These beams are connected by an elastic ring at their joint center and the shells carry the load as a two way three hinged arch.

Fourier analysis is applied to the bending theory of Marguerre and a very simple solution is obtained in the case of edge beams with sufficient bending rigidity.

JONSSON, IVAR G.: *On Turbulence in Open Channel Flow. Statistical Theory Applied to Micropropeller Measurements*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 31, Copenhagen 1965, 45 pp, Sw. kr. 10.00.

Longitudinal velocity fluctuations in uniform and steady open channel flow over a rough bed were studied by measuring the statistical variation of the velocity, averaged over certain time intervals, with a tiny aluminium propeller. A version of a statistical theory, used in meteorology, combined with a simple exponential form for the time correlation function, yielded values for the turbulent intensity and the macro time and length scales at different levels.

The measurements were compared with a number of other measurements and indicate, that the turbulent intensity and the length scale will increase with decreasing bottom roughness. A simple «eddy time» can be used as a measure for the time scale.

The investigation leads to a simple way of predicting the accuracy of mean velocity measurements in turbulent flows.

RØDAHL, EYSTEIN: *Economic sizing of hot-water heating systems with forced circulation*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 32, Trondheim 1965, 69 pp, Sw. kr. 10.00.

Equations for economical pipe sizes are derived for simplified two-pipe and one-pipe systems. Particularly the two-pipe direct return system, which is by far most used, is taken into consideration. For this piping arrangement the economical water temperature drop is also estimated.

In Norway, where the electricity is very cheap, the economical circulation head is in general too high to be accepted. It seems favourable to use the constant velocity design criterion for reversed return systems and the constant friction drop design criterion in general for direct return systems.

The economic water temperature drop seems generally to be somewhat lower than the normal temperature drop, 20° C. The total costs, however, vary little to each side of it. With regard to practical problems such as system balancing, the smaller the water temperature drop the more favourable it becomes. Thus, it seems favourable to use water temperature drops smaller than the hitherto normal value of 20° C.

PETTERSSON, OVE: *Structural Fire Engineering Research Today and Tomorrow*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 33, Stockholm 1965, 80 pp. Sw. kr. 10.00.

Fire engineering design of buildings and parts of buildings is at present characterised by procedures which are non-functional and undifferentiated from the viewpoint of structural design, and which are to a great extent based on regulations and recommendations. For instance, load-bearing structures are nowadays conventionally designed in a comparatively judicious fashion so as to take account of static and dynamic loads, whereas the state of fire engineering design gives rise to an undesirable lack of balance between these two fundamental and equivalent phases of structural design work.

The object of this publication is to evolve a theoretical procedure of structural fire engineering design which is intended to be qualitatively equivalent to the present-day methods of design for static and dynamic loads. The various steps of the design procedure in question are dealt with in detail, and are illustrated by examples which spotlight the scope of knowledge that is available in this field today. In this connection, mention is also made of the most important research problems which must be solved in order that the proposed procedure may be applied as generally as possible in the future.

The publication is to be regarded as a complement to the "General Programme for Scandinavian Long-Term Fire Engineering Research", which has been drawn up by the Author in the spring of 1963 at the request of the Inter-Scandinavian Liaison Group for Inter-Scandinavian Building Research Conferences, of the Liaison Committee of Scandinavian Fire Prevention Laboratories, and of the National Swedish Institute for Materials Testing, Stockholm.

FORSSBLAD, L.: *Investigations of Soil Compaction by Vibration*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 34, Stockholm 1965, 185 pp. Sw. kr. 20.00.

Effect of vibration on internal friction in soil materials; laboratory tests made by means of a vane borer on soils of various types at different moisture contents. Soil compaction tests made on a laboratory scale; compaction by vibration in an open mold and in combination with pressure applied to the surface of the soil sample. Investigation of impacts produced on ground surface by means of falling weights differing in dimensions; the pressure waves in the soil produced by the impacts were recorded. Compaction tests with vibrating rollers and vibrating plate compactors in combination with pressure measurements at different depths in the soil; the tests were partly performed with vibratory compactors differing in weight and in vibration characteristics. Risk of damage caused by vibratory compaction to neighbouring buildings. Compaction by internal vibration of water-saturated soils.

The main part of the laboratory and field tests were made at the Concrete and Soil Laboratory of AB Vibro-Verken, Stockholm, Sweden.

ENGELUND, FRANK and HANSEN, EGGERT: *Investigations of Flow in Alluvial Streams*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 35, Copenhagen 1966, 100 pp. Sw. kr. 10.00.

The first section concerns the two-dimensional flow over a fixed sinusoidal bed, taking account of non-hydrostatic pressure distribution in verticals. In the following section the corresponding flow on a movable bed is considered, a relation between flow and transport of sediment in case of non-uniform conditions being introduced.

The results of this investigation have been used to prove that the formation of dunes and anti-dunes is in fact a stability problem. A definite criterion for stable plane bed formation of dunes and antidunes was found and compared with observations of several experimenters.

The last sections concern the hydraulic resistance of flow in alluvial streams corresponding to different bed configurations.

Formulae have been found for the dimensions of the dunes and for the surface width of alluvial rivers.

JENSSEN, OSMUND and GUSTAFSON, ARVID: *On the Linear Elastic Thin Shell Theory for Nonshallow Shells with two Sets of Straight Generators*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 36, Trondheim 1966. 14 pp. Sw. kr. 10.00.

The bending theory of Vlasov for thin shells is extended to include shells with undamped solutions. The neglected terms in the theory of Vlasov which are of importance for this case are approximated by use of inextensional bending theory and the membrane theory. Two partial differential equations for the normal deflection and the stress function are obtained.

OVERGAARD, K. RASK: *Traffic Estimation in Urban Transportation Planning*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 37, Copenhagen 1966, 180 pp. Sw. kr. 20 00.

In an introductory chapter the different phases of the urban transportation planning process is described very briefly. The four basic steps in the traffic estimation procedure, namely trip generation, trip distribution, modal split, and traffic assignment, are presented in separate chapters. A Danish computer programme for trip distribution is described briefly in the final chapter, while a Danish programme for traffic assignment is discussed in more detail. This programme assigns traffic to a network in accordance with the principle of equal travel times.

BUCHHOLDT, H. A.: *Deformation of prestressed cable-nets*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 38, Trondheim 1966, 16 pp. Sw. kr. 10.00.

The paper gives a theoretically accurate method for calculating the forces and displacements of geometrical link assemblies which are structural mechanisms and not structures. The theory is based on the minimization of the total potential and the solution is by the method of steepest descent. A worked example of a small saddle-shaped cable-net subjected to increasing uniformly distributed load has been included to show the non-linearity of this type of problem.

PERSEN, LEIF N.: *Die theoretische Unterlage für die analytische Beschreibung der Wellenausbreitung im Felsen*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 39, Trondheim 1966, 126 pp, Sw. kr. 20,00.

Auszüge von der Theorie der Wellenausbreitung in einem viscoelastischen Medium sind gegeben. Die Theorie ist mit experimentellen Untersuchungen über die Wellenausbreitung in verschiedenen Gebirgskörpern verglichen. Eine gute Übereinstimmung ist gefunden.

Ci 40

UDC 624.131.6:624.152.61:627.33

CARLSEN, NILS A.: *Drainage of Quay Walls. Calculation of Overpressure behind Drained and Undrained Quay Walls*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 40, Copenhagen 1966, 46 pp, Sw. kr. 10,00.

The author deals with quay walls drained by either a row of drain wells along the wall or a horizontal drain blanket; quay walls without any special drainage provisions are also treated. The water level variation causing the overpressure is assumed to be a linear draw-down. Approximate formulae and diagrams for the overpressure, gradients and necessary drain capacity are obtained by calculation and by tests.

Ci 41

UDC 624.075.2:624.046

SEPPÄLÄ, VEIKKO: *On the calculation of the bearing capacity of an eccentrically loaded straight concrete column with a parabola as its stress-strain curve. Part II*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 41, Helsinki 1966, 28 pp. Sw. kr. 10,00.

In Part I (Acta Polytechnica Scandinavica No. Ci 21) of the paper a calculating method was presented for the bearing capacity of concrete columns with free or elastically clamped ends. This was based on the technical theory of bending. However, the restriction was made in Part I that the cross sections of the column should be rectangular.

In Part II the method has been generalized so that it is valid for columns with an arbitrary, symmetrical cross section including (with some restrictions) reinforced columns. In the theory presented, the fact has been taken into account, as in Part I, that the bearing capacity limit may be reached before or after the beginning of rupture.

The practicality of the method is demonstrated by calculating the bearing capacity for unreinforced concrete columns with an elliptical cross section and with free ends. The numerical calculations were performed with an electronic computer. The autocode programme tape was prepared so that it is universally appropriate, independent of shape and structure of the cross section as well as of the clamping moment in terms of the slope of the bending line at the end of the column.

ANDERSEN, V. MANDRUP: *Non-uniform flow in front of a free overfall*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 42, Copenhagen 1967, 25 pp. Sw. kr. 10.00.

Gradually varied flow in an open rectangular channel has been investigated on the assumption of small curvature of the streamlines. It has been shown that in the case of a flow in the neighbourhood of a free overfall the curvature of the streamlines cannot be neglected, although it is small.

A theory concerning such a flow has been developed and compared with experiments carried out in a hydraulic flume.

The investigation leads to a simple way of predicting the shape of the water surface upstream of the overfall, the end depth, end slope, and other characteristic values in connection with the flow.

GUNNERS, NILS-ERIK: *Methods of measurement and measuring equipment for fire tests. Joint inter-Scandinavian fire tests on lining materials for buildings at Copenhagen fire test house*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 43, Stockholm 1967, 45 pp. Sw. kr. 10.00.

Inter-Scandinavian tests concerning the characteristics of the process of fire development are carried out by the Liaison Committee of Scandinavian Fire Prevention Laboratories. The purpose of these tests is to investigate the thermal effects which a fire in an individual room produces on the surface layers of lining materials in a corridor that is connected by means of a door opening with the room where the fire is initiated.

The paper presents a study of the types and scopes of the separate measurement systems which are required for this investigation in order to determine the rate of combustion, the temperature fields, the heat flow due to convection and to radiation, the velocity of gas flow, and the composition of gases. New cylindrical pressure probes for measurements of the velocity of gas flow are proposed and the construction of a new total hemispherical radiation meter is presented.

DITLEVSEN, OVE: *Correlation functions for traffic load processes*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 44, Copenhagen 1967, 14 pp. Sw. kr. 10.00.

This work treats the so-called "waiting time paradox" in connection with calculation of covariance functions for the stochastic models for traffic loads on motor road bridges and railway bridges presented in a former paper "Statistical description of traffic loads on structures" (CI 28).

SCHJØDT, ROLF and BLEGEN, KJELL: *Wall and roof design for hot climates*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 45, Trondheim 1967, 22 pp. Sw. kr. 10.00.

The variations of temperature, radiation and air exchange demand that the walls and roof of buildings in hot climates have certain qualities as to heat capacity, insulation and colour, in order that the indoor temperature may be reasonably constant and as low as possible. With cooling and air-conditioning, the question of the economically justified amount of the corresponding materials also becomes important.

The present paper sets out the calculations necessary for the solution of these problems. The heat transmission equation is written as a difference equation, and attention is drawn to the, in the authors' opinion, unsatisfactory way in which this difference equation is often written.

Solutions, found with the help of a computer, are given for some designs. The amounts of heavy materials needed for heat capacity, and of light materials for insulation, are indicated.

HELLAN, KARE: *Analysis of elastic plates in flexure by a simplified finite element method*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 46, Trondheim 1967, 29 pp. Sw. kr. 10.00.

A finite element method for the analysis of thin linearly elastic plates in small displacement flexure is developed. The approach is based on an assumption of uniform curvature within each element.

Elements of triangular, rectangular and rhombic shape are considered. Their application is illustrated by six numerical examples.

MIKKOLA, MARTTI: *Lateral buckling on thin-walled curved beams beyond the limit of proportionality*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 47, Helsinki 1967, 30 pp. Sw. kr. 10.00.

The problem discussed is concerned with the lateral buckling of beam with a circular axis, and an open thin-walled cross section, when the stresses exceed the limit of proportionality. It is assumed that the Shanley principle is applicable. The effective modulus of elasticity is consequently the tangent modulus, and the effective modulus of rigidity is approximated on the basis of the deformation theory of plasticity. The cases studied are: (i) a bar with a cross section having one axis of symmetry in the plane of initial curvature, subjected to a radially directed and uniformly distributed load, and (ii) a bar with a cross section having two axes of symmetry, submitted to bending by two equal and opposite couples acting in the plane of initial curvature. Some numerical examples are worked out, and a graphical presentation is given of the relationships existent between the critical load and the length of the bar.

ÖDEEN, KAI: *Fire resistance of prestressed concrete double T units*. Acta Polytechnica Scandinavica, Civil Engineering and Building Konstruktion Series No. 48, Stockholm 1968, 75 pp. Sw. kr. 10.00.

An account is given of a method for determining by means of calculations the fire endurance of reinforced or prestressed concrete beams, and this method is specially applied to the fire grading of a certain definite type of prestressed concrete members, viz., double T units. The method in question is based on the calculation of temperature fields which are produced in the structure under exposure to fire. If the strength and deformation characteristics of the constituent materials at the temperatures under consideration are known, then the load-carrying capacity of the structure can be determined from these temperature fields. A survey is made of the present state of knowledge of the above-mentioned characteristics of materials, and it is shown that this knowledge is inadequate in some essential respects. In view of this fact, and taking into account some critical considerations concerning the standard fire endurance test procedures which serve as a basis for fire grading at the present time, only the principles of calculation of the load-carrying capacity under fire exposure are outlined, and the numerical evaluation is limited to a few characteristic examples.

HANSEN, JENS and SCHROEDER, HANS: *Horizontal jet dilution studies by use of radioactive isotopes*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 49, Copenhagen 1968, 23 pp. Sw. kr. 10.00.

Sewage discharge into receiving water often involves use of hydraulic jets in order to obtain an effective mixture of effluent and ambient water. The background for the present study is that existing theories on jet dilution processes have only poor experimental support, and that already presented experimental results are not in satisfactory agreement. The present experiments show an almost constant deviation from theoretically derived results.

The radioisotope tracer technique is found convenient for laboratory purposes since dilution measurements are easily and accurately carried out by use of either sampling technique or in-situ measurements.

Improvements in initial jet dilution may be obtained by using special disturbance arrangements placed in front of the jet orifice. Some special arrangements and their benefits are discussed in the present paper.

ÅKESSON, BENGT: *Thermally loaded elastic beams and plates. Analysed by displacement method in differential form*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 50, Stockholm 1968, 32 pp. Sw. kr. 10.00.

Concepts and terminology of the matrix-formulated analysis of structures composed of finite members are used to clarify and systematize the classical analysis of linearly elastic beams and plates by differential and integral calculus. Differential equations $(Ehw'')'' = q$ and $\Delta D \Delta w = q$ for laterally loaded beams and plates are interpreted as displacement method solutions where the role of structure stiffness is played by the differential operators $(d^2/dx^2)EI(d^2/dx^2)$ and $\Delta D \Delta$, and that of structure flexibility by corresponding integral operators. Special attention is paid to systematic treatment of temperature gradient load. Stresses and deflections are calculated. The involved chains of transformations are visualized by use of transformation diagrams. Two numerical examples are given.

BAEHRE, ROLF: *Das Tragverhalten von biegungsbeanspruchten statisch bestimmten und unbestimmten Balken aus elastoplastischem Material — theoretische und experimentelle Untersuchungen.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 51, Stockholm 1968, 76 pp. Sw. kr. 10.00.

Der vorliegende Aufsatz enthält ein Studium des Tragverhaltens von Balken aus elastoplastischem Material mit einer Arbeitskurve, die den Formänderungseigenschaften von Aluminiumlegierungen entspricht und im Spannungsbereich zwischen der Proportionalitätsgrenze und dem Bruchwert durch ein progressives Dehnungsverhalten gekennzeichnet wird.

Das Tragverhalten von statisch bestimmten und unbestimmten Systemen lässt sich mit Hilfe einer erweiterten Traglasttheorie beschreiben, die mit Ausnutzung des Prinzips der virtuellen Arbeit die Abschätzung des Formänderungsverhaltens bei beliebigen Laststufen erlaubt.

Die theoretische Behandlung wird durch einen Traglastversuch am Einfeldbalken mit einer speziellen Fließgelenkstudie ergänzt. Die Fließgelenkwirkung ergibt sich aus der Akkumulation mässiger Dehnungswerte in einem Bruch, der etwa der doppelten Balkenhöhe entspricht.

LARSSON, G. and RYDSTERN, O.: *Economic design of motor truck haul road systems in forest areas.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 52, Stockholm 1968, 85 pp. Sw. kr. 10.00.

The investigation is based on a method of design of forest road systems which has been expounded by one of the authors in an earlier publication. In the first place, this investigation deals with the magnitudes and the directions of those changes in the optimum system layout which are due to variations in different basic factors. It was found that the responses of the road system layout to such variations are as a rule relatively slight. In the second place, a series of new road system layout models is presented. In this connection, a study is made of the question how far the sets of formulae which are theoretically more correct but also more complicated can be replaced by simplified formulae. This study has led to certain approximate formulae, which give results whose accuracy is fully satisfactory for practical planning of forest road systems.

STUPNICKI, JACEK: *Analysis of the behaviour of wood under external load based on a study of the cell structure.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 53, Trondheim 1968, 62 pp. Sw. kr. 10.00.

The anisotropic behaviour of wood is studied theoretically and experimentally. An idealized model of the internal cellular structure of wood is constructed on the basis of microscopic observations. The behaviour of this model is expressed in mathematical form, and it is shown that it is possible by means of this model to explain qualitatively as well as quantitatively several significant features concerning the mechanical properties of wood.

CI 54

UDC 624.074.5
624.071.2

BUCHHOLDT, H. A.: *The configuration of prestressed cable nets.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 54, Trondheim 1968, 33 pp. Sw. kr. 10.00.

The paper gives mathematically developed expressions for the initial configuration of two, three and four directional prestressed cable nets with rectilinear boundaries in plan.

The configuration formulae, expressed in matrix form, are functions of the geometry at the boundaries and the pretensioning forces in the cables.

CI 55

UDC 532.135:624.12:624.035

PERSEN, LEIF N.: *Über die grundlegenden feldynamischen Beziehungen, die bei Schutzbauwerken im Felsen zu beachten sind.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 55, Trondheim 1968, 240 pp. Sw. kr. 30.00.

Es wird dargestellt, wie man versucht hat, ein verbessertes Verfahren für den Entwurf versenkter Schutzanlagen im Felsen auszuarbeiten. Sowohl theoretische Überlegungen als auch experimentelle Überprüfungen der Ergebnisse sind wiedergegeben.

CI 56

UDC 624.074.4

GUSTAFSON, ARVID: *A method for solving problems of non-shallow shells.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 56, Trondheim 1969, 17 pp. Sw. kr. 10.00.

The method developed in this paper is an extension of the Vlasov theory for thin shells to include also shells with undamped solutions.

By use of isometric coordinates the differential equations for the normal deflection and the stress function are transformed into an integral equation which may be solved successive approximations.

VUORELAINE, OLAVI: *Heat transfer problems in underground spaces.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 57, Helsinki 1969, 51 pp. Sw. kr. 10.00.

The present publication deals with the investigation of the temperature conditions in a subterranean channel, a metro tube, or a tunnel-like population shelter. For this purpose an expression is derived for the temperature field caused by a heated channel in its surroundings, in stationary state and in a case where the temperature of the wall of the channel is a known function of time. Furthermore, an expression is derived for the heat flow from the channel to the earth. In addition, the rise of the temperature of the channel wall is computed for constant heat effects of different size fed into the channel wall. Numerical examples computed by data machine, as well as nomograms, are presented for each case.

JENSSEN, OSMUND and PAPATZACOS, PAUL: *Note on the theory for thin elastic shells with small strains and moderately small rotations.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 58, Trondheim 1969, 23 pp. Sw.kr. 10.00.

An approximate non linear theory for shells with small strains and moderately small rotations (even about the normal to the shells) is given. The corresponding linear theory is also studied for shells with non zero Gaussian curvature.

The non linear theory of shells with small rotations about the normal is obtained in a compact form. In these theories, the expressions for strain and change of curvature of the middle surface are given with such an accuracy that the influence of the change of curvature on tangential equilibrium has to be included.

SALONEN, EERO-MATTI: *A gridwork method for plates in bending.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 59, Helsinki 1969, 31 pp. Sw.kr. 10.00.

There is a triangular plate bending element derived, composed of three bars along the sides of the element. Only the usual small deflection theory for thin isotropic plates obeying Hooke's law is dealt with. The bending and torsional stiffnesses of the bars of the element are arrived at by comparison of the differential equation of deflection of a regular triangular gridwork with that of a plate. The bending and torsional stiffnesses of a bar of the element are found to be identical and equal to one half of the product of the bending rigidity of the plate, the length of the bar and the cotangent of the angle corresponding the bar. The element is generally valid only when Poisson's ratio is zero. By merging elements of this kind together a gridwork is obtained, of which the analysis can be effected by a standard rigid-jointed gridwork program. Formulae are derived for calculating the stress resultants from the rotations of the joints. Numerical results from some examples are compared with other existing solutions.

BHARGAVA, J.: *Nuclear and radiographic methods for the study of concrete*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 60, Stockholm 1969, 102 pp. Sw.kr. 20.00.

Nuclear and radiographic methods were used for studying the factors which influence the properties of concrete cast in deep forms. Sedimentation of concrete in columns was studied by γ -ray transmission method; the variation in the moisture content along the height was studied by a neutron moisture gauge, and the distribution of cement was checked by tracer analysis. Zones of varying density and water content were observed in the columns, but there was no difference in cement content between the top and the bottom.

Structure of concrete was studied by penetrant dyes and by contact radiography of thin slices. Microcracks were found in concrete before loading. Radiography was used also for studying the cracking in concrete prisms during loading. In light of the results of these studies, the relation between the strength and the structure of concrete was critically reviewed.

JUMPPANEN, PAULI: *Bending of parallelogram plates*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 61, Helsinki 1970, 40 pp. Sw.kr. 10.00.

In this study, a solution is given to the problem of parallelogram plates with rigidly fixed or simply supported edges by application of the variational methods of Ritz and Bubnov — Galerkin. The deflection surface is approximated with the complete sequences of trigonometric functions and polynomials. The treatment is carried out without truncating the series. Thus the exact solution of the problem is obtained for the infinite number of terms in them.

The numerical treatment is effected only for rigidly fixed plates with arbitrary skewness and side ratio. For practical reasons, the number of terms in the series is restricted in the calculations. An investigation is made of Z. Kh. Rafal'sons' method in the evaluation of errors resulting from these restrictions. Finally, plates under uniformly distributed load and antimetric hydrostatic pressure are taken as examples for solution by means of digital computers.

ORDING, F. B.: *Die Genauigkeit der neuen norwegischen Karten in M 1: 50000 und mit E = 20 m*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 62, Trondheim 1970, 12 pp. Sw.kr. 10.00.

Diese Genauigkeitsuntersuchung umfasst 6 norwegische Kartenblätter wovon 5 in den letzten 20 Jahren konstruiert oder vermessen sind. Für jedes Blatt ist näher beschrieben, wenn und wie es hergestellt ist. Bis jetzt darf die gefundene Genauigkeit als sehr gut bezeichnet werden.

Ci 63

UDC 627.824.3.04

THURNER, HEINZ F.: *Stabilität der wasserseitigen Stützschiene eines Erdammes mit geneigtem Dichtungskern — theoretische und experimentelle Untersuchungen*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 63, Stockholm 1970, 107 pp. Sw.kr. 20.00. Die Stabilität einer kohäsionslosen Stützschiene wird teils für den trockenen Zustand und teils für die ungünstigste Lage des Stauspiegels unter verschiedenen mechanischen und geometrischen Bedingungen untersucht. Ein Gleichungssystem zur Berechnung der Stabilität wird mit Hilfe eines Computersystemes gelöst, die Resultate sind in Diagrammform zusammengestellt. Die Spannungsverhältnisse innerhalb der Stützschiene und in den an sie angrenzenden Bereichen werden mit Hilfe des Mohr'schen Spannungskreises für sowohl kohäsionslose, als auch für bindige Unterlagen (Dichtungskern und Dammbasis) der Stützschiene studiert. Eine analytische Lösung dieser graphischen Methode wird ebenfalls angegeben.

Mit Hilfe der Zeitlupenaufnahmen von 70 zweidimensionalen Modellversuchen konnten Lage und Richtung der beim Bruch einer trockenen Stützschiene auftretenden Gleitflächen näherungsweise bestimmt werden. Eine Serie von 35 Versuchen mit einem Sandmodell gestattete eine genauere Untersuchung der Gleitflächen, die mit Hilfe von in die Stützschiene eingepackten, schwarzen Sandsäulen nach jedem Versuch rekonstruiert werden konnten. Abschließend werden die verschiedenen Berechnungsmethoden an Hand eines Rechenexempels demonstriert.

Ci 64

UDC 532.582.7,532.5.013,3/4

NAVNTOFT, ERLING: *A Theory of the Velocity and Suspended Load Distribution in a Two-Dimensional Steady and Uniform Open-Channel Flow*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 64, Copenhagen 1970, 45 pp. Sw.kr. 10.00.

In Part I a similarity theory of steady and uniform open-channel flow carrying suspended load is developed. In the theory the fluctuations of the fluid-sediment mixture is described as an unsteady one-phase flow of a non-diffusive fluid with density gradients. The theory predicts a modified logarithmic velocity and suspended load distribution. In Part II the theoretical results are compared to experiments and a formula for the total sediment load is developed and compared to experimental values.

Ci 65

UDC 614.841.4

MAGNUSSON, S.-E. och THELANDERSSON, S.: *Temperature — time curves for the complete process of fire development. A theoretical study of wood fuel fires in enclosed spaces*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 65, Stockholm 1970, 129 pp. Sw.kr. 20.00.

Structural design of a fire-exposed building or part of a building presupposes knowledge of the temperature-time curve of the process of fire development. This knowledge is fundamental, and further progress towards more realistic design was therefore seriously impeded by the fact that existing methods permitted these curves to be computed for the flame phase only. The cooling period could not be dealt with. This paper extends and improves these methods so that the temperature-time curve for the complete course of the fire, the cooling period included, could be obtained.

A computer programme of general validity was developed, and with its aid more than 30 full scale fire tests were theoretically analysed. Finally, results from extensive computations, covering various conditions of fire load, of size and shape of openings and of the thermal properties of the constructions surrounding the enclosed space are given.

JENSEN, AAGE P.: *On failure in concrete*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 66, Copenhagen 1970, 59 pp. Sw.kr. 10.00.

The course of failure in concrete is investigated on the basis of the conception of concrete as a three-component material, consisting of matrix, coarse aggregate particles and contact zone.

A deterministic model is established which assumes rigid particles and rigid, perfectly plastic matrix and contact zone with no tensile strength. The model is used to analyze the commencement and propagation of failure in a test specimen and motivates a division of the course of failure into three stages.

The model is compared with test results from the literature and the results of tests carried out by the author in collaboration with the Concrete Research Laboratory, Karlstrup.

AUNE, PETTER: *Investigations on strength and stiffness of joints made with hydro-nail truss plates*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. CI 67, Trondheim 1970, 62 pp. Sw.kr. 10.00.

The paper presents test results for truss plate joints subjected to pure shear under axial load and joints subjected to moments.

Effect of grain direction and plate orientation is shown.

Formulae for maximum load and moment capacity being developed.

Load-slip and moment-deflection curves are given.

ELECTRICAL ENGINEERING SERIES

APS EI 1.

UDC 621.385.029.6

MATTILA, P., *On the Theory of the Electron Wave Tube with Elliptic Cross Section*. Acta Polytechnica Scandinavica (Acta P. 241/1958). Electrical Engineering Series 1, Helsinki 1958, 78 pp. Sw. kr 7:00

(Also State Institut for Teechnical Research, Finland, Publication No. 37).

In this paper the theory of the electron wave tube of elliptic cross section is derived. It is based on small signal theory. In the case of the elliptical tube the TM and TE waves contain Mathieu's functions. The development of electron beam waves on two completely mixed beams is studied in detail.

Comparison of the elliptic and circular cross section electron wave tubes is made. One practical example is worked out in detail. At small values of eccentricity it is possible to obtain nearly the same amplification with elliptic cross section electron wave tubes as with circular cross section tubes. With eccentricity approaching unity the amplification falls abruptly approaching zero as its limit.

APS EI 2

UDC 621.396.82:621.287.422

HYVÄRINEN, L. P., *The Autocorrelation Function and the Power Spectrum of Nonstationary Shot Noise*. Acta Polytechnica Scandinavica (Acta P. 252/1958). Electrical Engineering Series 2. Helsinki 1958, 20 pp. Sw. Kr. 7:00

The statistical power spectrum of the shot noise in a temperature-limited diode is derived by means of the autocorrelation function in the case that the cathode emission is a known function of time. Special attention is given to the case when the time dependence is periodic. The resulting spectrum is composed of a continuous noise spectrum proportional to the average current, upon which discrete signal frequencies are superimposed.

Another example of the nonstationary shot noise can be observed in the ionization chamber current when the radiation intensity varies with time.

APS EI 3

UDC 621.392.26

ANDREASEN, M. G., *Kurze Übergänge für H_{01} -Welle* (Acta P. 253/1959). Electrical Engineering Series 3. Copenhagen 1959, 22 pp. Sw. Kr. 7.00

Bei Übertragung der H_{01} -Welle des kreisrunden Hohlleiters durch einen konischen Übergang wird eine weiterlaufende H_{01} -Welle relativ stark angeregt. Um die Energieumwandlung in diese Welle klein zu halten, muss die Länge des konischen Übergangs relativ gross sein. Hier wird theoretisch untersucht, wie ein kürzerer Übergang erreicht werden kann durch geeignete Wahl der Form des Übergangs.

ANDREASEN, M. G., *Stetige Übergänge für H_{01} -Welle mit besonderer Berücksichtigung des konischen Übergangs*. (Acta P. 254/1959). Electrical Engineering Series 4, Copenhagen 1959, 25 pp. Sw. Kr. 7.00

Bei der Übertragung einer H_{01} -Welle durch einen stetigen Übergang zwischen zwei kreisrunden Hohlleitern verschiedener Durchmesser entsteht ein Energieverlust durch Reflexion und durch Umwandlung in andere, ausbreitungsfähige Wellentypen. Dieser Verlust wird berechnet und für einen konischen Übergang in Kurven dargestellt.

BJÖRK, NILS, *The Theory of the Indirectly Heated Thermistors. A Study of Thermistor Circuits 4*. Acta Polytechnica Scandinavica (Acta P. 255/1959) Electrical Engineering Series 5, Gothenburg 1959, 48 pp. Sw. Kr. 7: 00. (Also Chalmers tekniska högskolas Handlingar Nr 211)

In the earlier Parts 1 and 2 of the series, Acta Polytechnica 154 and 186 (Bibliography, Nos. 5 and 6) a theory of the directly heated thermistor has been given. In the present Part 4 this theory is extended to indirectly heated thermistors in order to make possible the handling of circuit problems where the dynamic properties of the indirectly heated thermistor are decisive.

In particular a small signal circuit for the indirectly heated thermistor is derived. The parameters of this circuit follow from an analytic expression of the resistance-power characteristic, which in its turn can be deduced from a few simple measurements.

The validity of the theory has been tested by experiments. The agreement was satisfactory.

ROMBERG, W., KELEN A. AND ÖSTERGREN L.: *Feldverteilung in einem dielektrischen Zylinder mit eingebetteter leitender Spirale*. Acta Polytechnica Scandinavica (Acta P. 261/1959) Electrical Engineering Series 6, Trondheim 1959, 14 pp. Sw. Kr. 7:00.

Zur Verbesserung der Durchschlags- und Alterungseigenschaften von Hochspannungsisolierungen aus Mikafolium oder ähnlichen geschichteten Isolierstoffen kann man die schwache Schicht (z. B. das Papier) schwach leitend machen. Wird eine solche Isolierfolie zusammenhängend um einen zentralen Leiter gewickelt, so entsteht ein dielektrisches Rohr mit eingebetteter leitender Spirale. Der Einfluss der leitenden Spirale auf die Feldverteilung im Rohr wird untersucht in Abhängigkeit von der Frequenz einer angelegten Spannung, von der Dicke der Isolierfolie, sowie von ihrer Leitfähigkeit und Kapazität pro Flächeneinheit. Eine feldausgleichende Wirkung der leitenden Spirale unter gewissen Bedingungen wird festgestellt.

SØRENSEN, E. V.: *Cavity Measurements of the TE₁₁ Propagation Constants of a Circular Waveguide Containing a Magnetized Ferrite Rod*. Acta Polytechnica Scandinavica (Acta P. 282/1960) Electrical Engineering Series 7, Copenhagen 1960. 19 pp. Sw. Kr. 7:00.

The propagation constants for the TE₁₁-like modes in a circular waveguide containing a slender, magnetized ferrite-rod have been measured for various ferrites at 4600 Mc/s by means of a tuneable waveguide cavity technique (M. van Trier).

The saturation magnetization, the dielectric constant and the permeability of the demagnetized ferrite have been derived from the results.

The maximum values of the ratio of Faraday rotation to insertion attenuation as calculated from the propagation constants appeared to be between one and two orders of magnitudes higher than the theoretical values based on the assumption of a Lorentzian resonance line shape (B. Lax). This emphasizes the need for a more satisfying loss-theory for microwave ferrites.

EKELÖF, Stig: *A Theory of the Eddy Current Equivalent Winding and its Application to the Closing of Non-Delayed Telephone Relays. A Study of Telephone Relays (4)*. Acta Polytechnica Scandinavica (Acta P. 304/1961.) Electrical Engineering Series 8, Stockholm 1961. 35 pp. Sw. Kr. 7:00.
Swedish Contribution No. 14.

In this paper the influence of the eddy currents on an telephone relay of the electromagnetic type on closing is investigated. The same relay as in Parts 1, 2, and 3 of the study is considered, i.e., an "L-armature" relay with a round core and a rectangular yoke, where the magnetic leakage is taken care of by the simplified field picture introduced in Part 1. The relay is assumed to have eddy currents in core and yoke. The armature is kept fixed and the magnetic reluctances are supposed to be constant.

The concept of an equivalent winding, representing the eddy current paths in a magnetic circuit, is subjected to a general theoretical treatment. It is shown that an equivalent winding should give useful results on closing but cannot be employed on breaking.

For the relay under consideration the equivalent winding parameters on closing are deduced. Numerical results are reported. The importance of the magnetic skin effect is pointed out.

MORATH, ERIK: *Skin-effect losses during the commutation of d.c. machines*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 9, Stockholm 1965, 81 pp. Sw. kr. 10.00.

The losses caused by the skin effect during the commutation of d.c. machines have been calculated with the aid of Poynting's radiation vector, via Laplace transforms, also for the case where both conductor layers of the slots do not commute simultaneously.

It is possible to reach a solution by means of harmonic analysis instead of the Laplace transforms used. This has not been done, however, since the method selected appears to be simpler.

The time constants and the resistances are referred to the sum of the strands of the conductors. This has the advantage that the losses for all possible strandings can be calculated with little extra trouble.

The results have been presented in a form well suited for computers. Tables and diagrams have also been drawn up to facilitate manual calculations.

EI 10

UDC 519.14:537.311:537.313

VIRKKUNEN, JOUKO: *Combinatorial problems in the theory of ladder networks*. Acta Polytechnica Scandinavica, Electrical Engineering, Series No. 10, Helsinki 1965, 64 pp. Sw. kr. 10,00.

This study is concerned with the graph-theoretical properties of the ladder graph, the main incentive for the work being application of the results to the electrical network theory. As a consequence, the principal interest has been devoted to the trees of the ladder.

All the trees of an n -stage ladder have been analysed, and an efficient method for their generation is given. The totality of the trees is divided into different subsets, and the number of trees in each subset given. The combinatorial numbers which arise in this study are subjected to brief discussion, supplemented by the Appendices.

In conclusion, the author has calculated some electrical characteristics of the ladder, such as the four-pole parameters. The three systematics provide great freedom in selection of the input- and output-vertices of the ladder. Some examples of the use of the results are included, along with the necessary tables of combinatorial numbers arising in the study.

EI 11

UDC 621.313.33.001.11

MORATH, E.: *Grundlagen zur theoretischen Untersuchung der Eigenschaften von Asynchronmaschinen*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 11, Stockholm 1966, 40 pp. Sw. kr. 10,00.

Eine theoretische Untersuchung der wechselnden Eigenschaften von Asynchronmaschinen lässt sich gemeingültig durchführen, wenn die Wicklungen der Maschinen als induktiv gekoppelte Kreise aufgefasst werden. Es zeigt sich, dass die Ergebnisse für die Behandlung von Ausgleichsvorgängen verschiedener Art gut geeignet sind.

Die hier veröffentlichte Methode ist sehr allgemein. Sie kann mit Vorteil angewendet werden, um z. B. die Eigenschaften thyristorgesteuerter Maschinen, oder die Auswirkungen bei nicht gleichzeitiger Einschaltung der Phasen einer Maschine zu studieren. Es muss jedoch beachtet werden, dass die hier erörterten Beziehungen für Maschinen mit getrennten Phasen aufgestellt wurden und also dort ihre grösstmögliche Gültigkeit besitzen. Praktisch vorkommende Schaltungen können deshalb gewisse Modifikationen erforderlich machen. Diese werden am besten von Fall zu Fall durchgeführt.

EI 12

UDC 621.317.32

OHLON, R.: *A study of two electrostatic methods for the absolute measurement of voltages*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 12, Stockholm 1966, 46 pp. Sw. kr. 10,00.

Two electrostatic methods for the absolute measurement of voltages are studied with the intention of forming an idea of the potential possibilities of the methods. One of the methods is based on the measurement of the oscillations of a pendulum. This method is best suited for the measurement of high voltages (> 10 kV), both direct and alternating. The accuracy of the method has been estimated to correspond to a maximum total error of approx. 0.02%, the partial errors being assumed to be compounded in accordance with the law of error propagation. The other method is a modification of a Kelvin-electrometer. When measuring the voltage levels of standard cells, the accuracy under the same assumptions as above has been estimated to be 10 ppm.

HORSTOCK, NOAH: *Scattering matrix description of general linear networks (n-ports) with application to the design of uni-directional devices.* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 13, Copenhagen 1966, 59 pp. Sw. kr. 10.00.

The concept of scattering coefficients is reviewed and generalized to suit the description of linear periodically time-varying n-ports. The scattering matrix is defined with respect to two sets of reference admittances and not one as in the conventional approach. With this approach, it is shown that almost every 3-port, belonging to a certain class of networks, have properties similar to those of a circulator.

A special attention is paid to reactive networks. It is shown that the two sets of reference admittances are strongly interconnected.

Using the developed theory, it is shown that the following circuits might be realized employing parametric devices and elementary linear time-independent components only: 1) a circular (3 varactor diodes); 2) an isolator (2 varactor diodes); 3) reflection type 3-port amplifier (2 varactor diodes); 4) reflection type 4-port amplifier (2 varactor diodes).

Circuit 3 is equivalent to the conventional parametric amplifier which employs a 3-port circulator.

RAHKO, K.: *The dimensioning of local telephone traffic routes based on the distribution of the traffic carried.* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 14, Helsinki 1967, 95 pp. Sw. kr. 10.00.

It has been demonstrated with the aid of χ^2 tests, that a Weibull distribution provides a good fit for traffic on national routes. With the parameters of this distribution as a basis, the number of lines on a route can be selected to correspond to the desired level of blocking, employing the Weibull blocking curves presented in Appendices 2 ... 7.

Moreover, a normal distribution provides a better fit than a Poisson distribution. For this reason, blocking values based on the parameters of the normal distribution are shown in Appendix Tables 1 ... 7.

The present permissible level of blocking could be raised roughly five-fold if two or more parameters of the distribution of the traffic on the route were used for dimensioning the route.

The true blocking on routes must be checked continually. A good method is that of measuring the peak-traffic parameters; this calls for only two call counters to each route. The same method provides adequate material for forecasting traffic parameters on which to base route enlargements.

SCREENING COMMISSION OF THE NEW UNIVERSITY HOSPITAL, COPENHAGEN, DENMARK: *Reduction of electrical interference in measurements of bioelectrical potentials in a hospital.* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 15, Copenhagen 1967, 37 pp. Sw. kr. 10.00.

For the recording of potentials from the brain, heart, muscle and nerves everywhere in a hospital the wiring of the mains is the main source of interference. Other sources are electro-surgical apparatus either unscreened, or screened when used with a long electrode such as a pair of forceps. Other sources of interference are diathermy apparatus, radio transmitters, radio paging systems and various electrical machines. To prevent interference the mains wiring and lighting fixtures should be screened and the ascending lines installed in such a way that magnetic disturbances are reduced. Room screening can be confined to neurosurgical operation theatres, rooms where diathermy is used and rooms where unusually sensitive recording apparatus is to be tested, developed or in constant use. Radio paging systems should transmit on frequencies of 40-60 MHz.

KELEN A.: *Studies on partial discharges on solid dielectrics — a contribution to the discharge resistance testing of insulating materials*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 16, Stockholm 1967, 138 pp. Sw. kr. 20.00.

The work consists of the following four parts:

1. Partial discharge resistance testing of insulating materials.
2. Application of isothermal calorimetry for measuring power dissipation caused by partial discharges (together with J. AASE).
3. A study of the mechanism of partial discharges by insulating surfaces.
4. Some observations of the treeing breakdown in epoxide resins (together with L.-E. LARSSON).

KARTTUNEN, PAULI: *Dynamic model systems and time optimal position control of the induction machine*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 17, Helsinki 1968, 75 pp. Sw. kr. 10.00.

This study is concerned with the development of dynamic model systems for the induction machine, the use of these model systems for the solution of some time optimal control problems of the induction machine, and the application of the time optimal solutions thus obtained as comparison models in the evaluation of some alternative suboptimal solutions. With a view to the attainment of maximum generality and simplicity, most of the quantities included in the final systems are suitable "per unit" quantities. Special attention has been paid to the time optimal position control problem of the induction machine. However, since this represents no more than a special case of a more general problem, an attempt has been made to keep the introductory consideration as general as possible.

KALLIOMÄKI, K.: *An analysis of the modulated frequency stabilizer and of the absorption detector for microwave reaction cavity measuring systems using a new diode model*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 18, Helsinki 1968, 48 pp. Sw. kr. 10.00.

A modulated reaction cavity frequency stabilizer and reaction cavity absorption detector for microwave measuring circuits have been analyzed by a new diode model. This new diode model is a simple analytical function, which is compared with the rigorous model, derived from the exponential function. The new diode model is also compared with the results measured at different frequencies.

JANI, ASHWINKUMAR CHANDRAKANT: *Design aspects of a massive iron rotor equipped with a sandwiched squirrel-cage*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 19, Helsinki 1968, 61 pp. Sw. kr. 10.00.

This study is concerned with the development of a massive iron rotor equipped with a sandwiched squirrel-cage. Impedance relations required for design purposes have been developed which are based on steady state conditions and assumptions.

Experimental results have been given and calculated values are compared.

MARIN, LENNART: *On the coupling between two adjacent rectangular waveguides through a slot in the common wall*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 20, Stockholm 1969, 39 pp. Sw. kr. 10.00.

Two boundary value problems involving rectangular waveguides are investigated. In the first problem we have a half infinite slot in the common wall. The analysis leads to two different systems of one dimensional integral equations. The solution of these equations gives the tangential component of the electric field on the slot. In the second problem we have a finite rectangular slot in the common wall. This problem is easily solved when we know the solution of the first problem. The result is applied to the determination of the scattering matrix for the dominant TE_{10} -mode.

OTALA, MATTI: *The theory and construction of a proposed superconducting aeromagnetic gradiometer*. Acta Polytechnica Scandinavica, Electrical Engineering Series No 21, Helsinki 1969, 56 pp. Sw. kr. 10.00.

A new method for the accurate measurement of magnetic gradient has been developed. The principle uses the pair-to-quasiparticle tunnelling transitions of superconducting thin-film junctions. A four-junction drift — compensating gradient sensor has been devised and analyzed. The principle has been applied in an airborne magnetic gradiometer for aeromagnetic surveying. The construction of a digital data extraction and storage unit registering the gradient with relevant flight data has been described. The gradiometer is capable of the automatic drawing of the gradient iso-anomaly map in an off-line connection with an IBM 360/30 computer. The salient properties of apparatus have been discussed.

BRANDQVIST, L.: *An investigation of the nonlinear instability phenomena associated with the application of asynchronous machines to power sources containing complex networks*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 22, Stockholm 1969, 70 pp. Sw. kr. 10.00.

A theory for the nonlinear instability phenomena associated with the application of asynchronous machines to power sources containing complex networks has been developed and the general stability boundaries associated with the different mechanisms of instability has been derived. An experimental verification of the theory has been performed and the results obtained have been found to be in good agreement with the theory.

EINARSSON, O.: *Electromagnetic scattering by a thin finite wire*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 23, Stockholm 1969, 36 pp. Sw.kr. 10.00.

Scattering of a plane electromagnetic wave by a straight, perfectly conducting circular cylinder, whose radius is small compared to both its length and to the wavelength, is investigated theoretically. The surrounding medium is air (vacuum) and the incident wave is linearly polarized with the magnetic field perpendicular to the cylinder axis. The work is based on the traveling wave solution for scattering by a circular, finite, thin-walled tube, obtained by repeated use of the Wiener-Hopf method. A closed form expression for the far field, for arbitrary angles of incidence and observation, is obtained by expanding this solution asymptotically in negative powers of a quantity of order $\ln ka$. Second order terms are included in the expansions and to improve the numerical accuracy the original form instead of an asymptotic expression is used for some numerically sensitive quantities. Scattering cross sections are computed and compared to existing theoretical and experimental results.

HJELT, SVEN-ERIK: *On the calculation of current and temperature distributions in a thin conducting strip between magnetic pole faces*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 24, Helsinki 1970, 54 pp. Sw.kr. 10.00.

In the first part one-dimensional current densities have been calculated in order to find limits where the secondary field of the induced currents can be neglected in comparison with the original field. The current density is found as the finite-difference solution of an integrodifferential equation, when the strip is between infinite flat poles, at the edge of a magnetic pole pair and at the crossing between two pole pairs of opposite polarity. The source-function of the currents is found using conformal transformation. For a Cu-strip 0.5 mm thick, 300 mm wide in 10 mm air gaps the secondary fields can be neglected at mains frequency, 50 Hz.

In the second part two-dimensional current densities and their temperature distributions are calculated neglecting the secondary field, temperature dependences of the material constants and heat conduction. The external field as a function of coordinate across strip width is optimized to give temperatures constant with an accuracy of 1 % when the strip moves through pole structures of same width as the strip.

MATHEMATICS AND COMPUTING MACHINERY SERIES

APS Ma 1

UDC 621-52:517.512.2:621.316.7.078

BALCHEN, JENS G., *A Performance Index for Feedback Control Systems Based on the Fourier Transform of the Control Deviation*. Acta Polytechnica Scandinavica (Acta P. 247/1958) Mathematics and Computing Machinery Series 1. Trondheim 1958, 22 pp. Sw. Kr. 7:00.

The paper discusses some commonly used performance indices for optimum adjustment of linear control systems. A new index is developed which is simple to apply in conjunction with a graphical frequency response analysis. A method for introduction of additional constraints assuring proper system stability and damping is demonstrated.

APS Ma 2

DK 517. 512. 2

HYVÄRINEN, L., *Fourier Analysis, a New Numerical Method*. Acta Polytechnica Scandinavica (Acta P. 248/1958) Mathematics and Computing Machinery Series 2. Helsinki 1958, 19 pp. Sw. Krona 7: 00
(Also State Institute for Technical Research, Finland, Publication No. 38)

A numerical method for the calculation of Fourier series coefficients a_n and b_n for an empirical function $f(x)$ based on sums of the form $\frac{1}{n\sqrt{3}} \sum_{\nu} (-1)^{\nu} f_{\epsilon} \left(\frac{1-6\nu}{12n} \right)$

and $\frac{1}{n\sqrt{3}} \sum_{\nu} (-1)^{\nu} f_o \left(\frac{1-3\nu}{6n} \right)$, where f_{ϵ} and f_o are the even and odd parts of one period of $f(x)$ with period equal to unity. The evaluation of the sums is facilitated by a semi-graphical method using a template on which are marked the points $1 - 6\nu/12n$ and $1 - 3\nu/6n$ respectively.

The sums corresponding to a_n or b_n contain $2n$ -terms, hence the work needed for the computation of the n th harmonic grows directly in proportion to n .

The coefficients a_n, b_n obtained from the above sums have to be corrected for the harmonics of orders $6mn \pm 1$ ($m = 1, 2, 3, \dots$). If the series converge rapidly enough, only the first few coefficients need correction. The absolute accuracy of the coefficients is proportional to $1/\sqrt{n}$, thus the higher ones are obtained with better absolute accuracy.

APS Ma 3

UDC 518.5:621.316.7

HOLBERG, KARL and JENSEN, JENS R., *Table of $W = Z/(1+Z)$ for Complex Numbers*. (Acta P. 257/1959). Mathematics and Computing Machinery Series 3, Copenhagen 1959, 149 pp. Sw. Kr. 14:00.

In design of automatic control or feedback systems it is very often necessary to calculate $W = \frac{Z}{1+Z}$ or $V = \frac{1}{1+U}$ where Z and U are complex numbers.

It has been common practice to use a graphic method in the ϕ -dB plane, which requires a special graph paper known under the name Nichols chart.

Following the general trend towards substituting analog calculation devices or methods by more accurate digital ones the need for a suitable table has arisen, and the function $W = W(Z) = \frac{Z}{1+Z}$ is hereby presented in a tabulated form.

APS Ma 4

UDC 621-52:517.512.2

BALCHEN, J.G. AND BERRE, A.G.: *A Method for Evaluating the Accuracy in the Time Domain Associated with Approximation in the Frequency Domain*. Acta Polytechnica Scandinavica (Acta P. 262/1959) Mathematics and Computing Machinery Series 4, Trondheim 1959, 12 pp. Sw. Kr. 7:00

A method is outlined which makes it possible by simple means to estimate the error in the time response arising from a certain inaccuracy between an exact and an approximate system in the frequency domain. A new error criterion which makes use of logarithmic amplitude and frequency plots is introduced.

APS Ma 5

UDC 518.5:003.62

NAUR, Peter (Editor): *Report on the Algorithmic Language ALGOL 60*. Acta Polytechnica (Acta P. 284/1960). Mathematics and Computing Machinery Series 5, Copenhagen 1960. 40 pp. Sw. Kr. 7:00.

The report defines and describes the international algorithmic language ALGOL 60. This is a concise language for expressing numerical processes.

The report contains: The historical background. An explanation of the notions reference language, publication language and hardware representations. A general survey of the language. A list and explanation of basic symbols and basic concepts. Definitions of arithmetic, Boolean, and designational expressions. Definitions of the statements (operational units). Definitions of declarations.

The report ends with some examples and an alphabetic index of definitions.

APS Ma 6

UDC 92 Erlang
519.2:621.391 (09)

BROCKMEYER, E., HALSTRØM, H. L., and JENSEN, Arne: *The Life and Works of A. K. Erlang*. Acta Polytechnica Scandinavica (Acta P. 287/1960). Mathematics and Computing Machinery Series 6, Copenhagen 1960. 277 pp. Sw. Kr. 21:00.

This publication is intended to be a complete edition of A. K. Erlang's principal works which have been available hitherto in the form of articles in Danish and foreign journals only. It contains the following chapters:

- "The life of A. K. Erlang",
- "An Elucidation of A. K. Erlang's Statistical Works through the theory of Stochastic Processes",
- "A Survey of A. K. Erlang's Mathematical Works",
- "A Survey of A. K. Erlang's Electrotechnical Works",
- "Principal Works of A. K. Erlang",
- "Table of Erlang's Loss Formula",
- "List of A. K. Erlang's Publications in Chronological Order".

RICKMAN, Seppo: *The Method for Construction of the Solution of Ordinary Differential Equations with the Aid of the Complex Plane*. Acta Polytechnica Scandinavica (Acta P. 323/1962) Mathematics and Computing Machinery Series No. 7, Helsinki 1962, 28 pp. Sw. Kr. 7:00.

Finnish Contribution No. 36.

A partially graphic method for the solution of ordinary differential equations is presented, in which the Laplace transformation is employed to represent the state of the differential equation at given intervals in the complex plane by poles and zeros. This is possible owing to the procedure of assuming the differential equation to have constant coefficients in each interval. At first, the theory is carried through in its entirety in a coarse shape, determining the constant coefficients on the basis of the initial points of the intervals, while in the second approximation they are determined by the centre-points of the intervals. As applications, one linear differential equation of the third order and two non-linear differential equations of the second order are treated.

APS Ma 8

UDC 517.512.2

ANDERSEN, Chr.: *The Ruler Method. An examination of a Method for Numerical Determination of Fourier Coefficients*. (With an introduction by Viggo A. Kjer: Harmonics by Torsional Vibration). Acta Polytechnica Scandinavica. Mathematics and Computing Machinery Series No. 8, Copenhagen 1963, 10 pp. Sw. Kr. 10:00.

Professor Viggo A. Kjer of the Technical University of Denmark has developed a special set of rulers to determine the approximate values of the Fourier coefficients for a function, which is given by its graph. The use of the rulers and some results obtained are treated in the introduction, "Harmonics by Torsional Vibration" written by professor Kjer.

Further the "ruler method" is examined in detail. The relation between the coefficients obtained by the ruler method and the Fourier coefficients is established, and the ruler method is compared with the method of Runge.

The major part of the examination consists of a numerical investigation. The numerical work was carried out on the Danish computer, DASK.

Ma 9

UDC 518.61:517.946.6

SALA, I.: *On the numerical solution of certain boundary value problems and eigenvalue problems of the second and fourth order with the aid of integral equations*. Acta Polytechnica Scandinavica. Mathematics and Computing Machinery Series No. 9, Helsinki 1963, 24 pp. Sw. Kr. 10:00.

In a previous volume of this series of publications (APS Me 11) the author has used a method of solving certain eigenvalue problems of the fourth order which is based on the method presented by Nyström for the solving of certain boundary value problems of the second order. The method has, however, the defect that it does not converge even though it may give good results with small numbers of base arguments. — This disadvantage has in the present investigation been avoided by the use of a method in which the definite integral in the integral equation is replaced by the weighted sum of a certain number of base ordinates chosen equidistant according to the method used by Archimedes in his investigations on the circle and on the parabola. These base ordinates represent the entire function to be integrated including Green's function.

The solving of the frequency equation and of the equation which determines the eigenfunction, respectively, both in matrix form, is well adapted to automatic computation.

Ma 10

UDC 518.5:548.735.44

LIMINGA, Rune and OLOVSSON, Ivar: *Some Crystallographic Programs for the Computers, BESK and FACIT EDB*. Acta Polytechnica Scandinavica. Mathematics and Computing Machinery Series No. 10, Uppsala 1964, 12 pp. Sw. Kr. 10,00.

A series of programmes for the calculation of structure factors and summation of Fourier series is described. These programs can handle practically all space groups without writing subroutines. The reflexions can occur in any order and no sorting is necessary between changes of the summation order. The intervals are completely general. A program for systematic evaluation of distances and angles is also described.

The programmes have been written for the Swedish computers BESK and FACIT EDB.

Ma 11

UDC 539.194:518.5:003.62

BRUNVOLL, J. AND CYVIN, S. J.: *GIER-ALGOL Programming of the B Matrix in the Theory of Molecular Vibrations*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 11, Trondheim 1964, 19 pp. Sw. kr. 10,00.

A GIER-ALGOL programme called "BAMBOO" for computing the B matrix ($S = BX$) in the problem of molecular vibrations is described. The programme is based on the s vectors for the standard types of valence coordinates (stretching, bending, out-of-plane bending, and torsion). It requires the INPUT of position vectors for the atoms of a molecule in its equilibrium position, the valence coordinates (R) specified in a simple way, and information on the U matrix ($S = UR$).

The produced B data for specific molecular models and individual molecules may be stored on paper tapes for use in future spectroscopic computations. For this purpose we have developed a convenient system. The B data are stored along with data tapes for BAMBOO and small intermediate programmes for producing the position vectors.

Ma 12

UDC 624.074.4:517.949

HELLAN, KÅRE: *Application of a Numerical Procedure to the Analysis of Thin Cylindrical Shells*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 12, Trondheim 1965, 40 pp. Sw. kr. 10,00.

A thin elastic cylindrical shell under the action of external forces is considered. Its thickness is assumed uniform in the longitudinal (generatrix) direction, while normal to this in the circumferential direction the thickness as well as the curvature may vary in any continuous or discontinuous manner. The shell is bounded by straight longitudinal edges and curved circumferential edges. No severe restrictions apply to the boundary conditions along the straight edges, but it is assumed that the curved edges are simply supported or clamped. The deformations are assumed to be small, permitting the analysis by first order theory. A general finite difference solution is given, on the physical basis that the real shell surface is approximated by one of prismatic shape.

KOWALIK, JANUS: *Nonlinear Programming Procedures and Design Optimization*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 13, Trondheim 1966, 47 pp. Sw. kr. 10.00.

This paper presents a survey of the presently available methods of structural optimization by means of nonlinear programming.

Two nonlinear programming procedures, which have been used with success, are presented in detail, including flow charts.

The methods are of a general nature and could be applied to various fields of engineering, economics etc.

To illustrate the methods, two numerical examples are presented.

HELLAN, KARE: *A numerical method of analysis of orthotropic and inhomogeneous cylindrical shells*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 14, Trondheim 1967, 51 pp. Sw. kr. 10.00.

A thin elastic cylindrical shell under the action of external forces is considered. Orthogonal anisotropy is assumed with respect to the surface coordinates in the circumferential and the longitudinal (generatrix) direction. The elastic properties are uniform in the longitudinal direction, but they — as well as the curvature — may vary arbitrarily in the circumferential direction. Loading conditions are unrestricted. No severe limitations apply to the boundary conditions along the straight longitudinal edges, but it is assumed that the circumferential edges are simply supported or clamped. The deformations are assumed to be small, permitting the analysis by first-order theory. A finite difference solution is given, on the physical basis that the real shell surface is approximated by one of prismatic shape.

SALOVAARA, SAMPO: *On set theoretical foundations of system theory*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 15, Helsinki 1967, 78 pp. Sw. kr. 10.00.

The work involves an investigation of the set theoretical model of a dynamic system. The aim of this work is that of generalizing and giving precision to the concept of state of the system.

The research is founded upon the first two chapters of Zadeh & Desoer's book "Linear System Theory". The starting point for work was the principle that the dynamic system is a relation. The structure of the relation has been enriched when necessary.

It has been shown, that the parametrization of a relation (the covering of the relation with certain sets of mappings) leads logically to a precisely defined state concept. This state does not presume the non-anticipativity of the system.

ERLANDER, SVEN: *Optimizing nonlinear models of certain transportation and inventory systems*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 16, Stockholm 1968, 208 pp. Sw. kr. 20.00.

The following problem is considered:

Given a number of producers and customers with specified production capacities and demand, a road network connecting the producers with the customers, vehicles of certain types but not specified in number, and given costs of transportation and inventory,

find which routes the vehicles shall drive and how often in order to minimize total cost of transportation and inventory for the system subject to the constraints imposed by the given production capacities and demand. The problem is formulated as a nonlinear programming problem.

By using Kuhn-Tucker theory sufficient and in a certain sense necessary conditions for an optimum solution are obtained. By slightly reformulating the problem Wolfe's generalized program technique will be applied to give an algorithm that determines an optimal solution in a finite or denumerable number of steps.

Finally numerical results from a real world application of the algorithm are given.

Ma 17

UDC 532.57:621.039.8:518.5

SJÖSTEDT, T.: *Computer evaluation of tracer investigations on systems, when output flow is recirculated to the inlet*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series 17, Stockholm 1969, 19 pp. Sw. kr. 10.00.

Radioactive tracers are often used for determination of the residence time distribution for material flow through a system. When a fraction or all of the output flow is recirculated to the inlet, the residence time distribution must be computed from the recorded concentration-vs.-time curve at the outlet. The required equation for doing this is derived, and numerical calculations based on the derived formula are discussed and illustrated. Equations are also derived, which permit calculation of the moments of the residence time distribution from parameters taken from the recorded tracer concentration.

Ma 18

UDC 62-501.72:519.28

SEGERSTÄHL, BORIS: *On the computation of density functions of parameters in stochastic systems*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 18, Helsinki 1969, 44 pp. Sw. kr. 10.00.

A time-discrete stochastic system is defined by means of a probability triplet (an experiment) $E = (S, F, P)$ which determines the density function of the parameter in the system.

The effect of a measurement (through a change of the probability measure P in the experiment) on the stochastic system is investigated. It is shown that as a result of the measurement the parameter can be substituted by an a posteriori parameter with dimension one less than the dimension of the parameter.

The problems consist of the computation of various conditional density functions assuming that a measurement on a realization of the stochastic system has been made. The solutions are given as algorithms involving only matrix computations of fixed dimensionality.

BLOMBERG, HANS, SINERVO, JYRKI, HALME, AARNE and YLI-NEN, RAIMO: *On algebraic methods in systems theory. Ordinary linear time-invariant differential systems*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 19, Helsinki 1969, 43 pp. Sw.kr. 10.00.

This study is aimed at demonstration of how algebraic methods can be used to treat ordinary linear, time-invariant differential equations. The starting point is the $C(p)$ -module D , where D is the class of complex generalised functions on the real line, and $C(p)$ the ring of derivative polynomials with complex constant coefficients. The concept of an ordinary linear, time-invariant differential system is defined. The transfer matrix of a differential system is introduced, and the minimal differential system associated with a given transfer matrix defined and constructed. Basic interconnections of systems in general are considered. In the case of differential systems, the new systems formed by the aid of these interconnections, provided that certain conditions are fulfilled, prove to be again differential systems. Finally, a presentation is made of the so-called "principle of projection". This principle makes it possible to pass from the calculus in the $C(p)$ -module D to a calculus in a corresponding projected module which is a vector space over the field of quotients of $C(p)$.

JIROUSEK, J.: 1. *Bending of cylindrical shells solution using cylindrical strip elements*. 2. *Finite element analysis of cylindrical shells solution using rectangular circular cylindrical elements*. Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series No. 20, Stockholm 1970, 57 pp. Sw.kr. 10.00.

Principle of the solution — stiffness matrix of the cylindrical strip element — recurrent form of solution suitable for digital computers — cylindrical shells with longitudinal ribs — standard routines in ALGOL language — some results of the solution.

MECHANICAL ENGINEERING SERIES

APS Me. 1.

UDC 621.9.025:620.178.16:539.16.004.14

COLDING, B., *Testing of Machinability by Radioactive Methods*. Acta Polytechnica Scandinavica (Acta P. 243/1958) Mechanical Engineering Series 1, Stockholm 1958, 42 pp. + figs. Sw. Kr. 7: 00

A large number of machinability tests were carried out on five different materials cut by radioactive carbide cutting tools. The tests were carried out in an ordinary lathe, which was provided with radiation shield. The wear on the carbide tools was determined by measurement of the radioactivity of the chips cut.

The rate of wear after a rather brief running-in period was approximately constant up to the time the tool wore out, so that the mean activity in the chips produced during a few minutes' turning constitutes a relative measurement of the rate of wear. By means of reference measurement absolute values for the tool-lives were obtained. The β and γ methods used gave approximately the same degree of accuracy, i.e. varying between $\pm 2\%$ and $\pm 20\%$ for about 10 measurements.

The total cost of test for a tool-life curve using the radioactive method is appreciably lower than the corresponding cost with the conventional method.

APS Me 2

UDC 534.838.1:629.12.07

KJÆR, VIGGO A, *Vertical Vibrations in Cargo and Passenger Ships*. Acta Polytechnica Scandinavica (Acta P. 244/1958) Mechanical Engineering Series 2, Copenhagen 1958. 52 pp. Sw.Kr. 7:00

A formula and a corresponding curve are given for permissible displacements depending on the frequencies of vibration. The ratio of actual displacements to permissible displacements is called the vibration factor, and vibration characteristics are presented showing the vibration factors at important positions on certain ships.

A calculation of the vibration amplitude is made for the case of resonance between the exciting forces from the machinery and the natural frequencies of the hull. The calculation is based on an expression for the damping, which includes a damping factor found by investigations to vary very little even for ships of different dimensions and with vibrations of different frequencies.

One section deals with vertical vibrations due to torsional vibrations in the crank shaft.

APS Me 3

UDC 539. 431. 3: 669-162: 621. 791. 7

EIRO, OLAVI, *Die Ermüdungsfestigkeit des Schweissmetalls*. Acta Polytechnica Scandinavica (Acta P. 250/1958) Mechanical Engineering Series 3, Helsinki 1958, 26 pp. Sw. Krona 7: 00

(Also State Institute for Technical Research, Finland, Publication No. 39)

In der Abhandlung sind die Eigenschaften des reinen Schweissmetalls, das mit erzsäuren, basischen und Organrutilen elektroden geschweisst wurde, unter dynamischer Beanspruchung ergründet worden. Die Wirkung des Wasserstoffes auf die dynamische Festigkeit wurde durch Probeserien festgestellt, die nach der Standzeit von 4 Stunden, und von 10 (20) Tagen ausgeführt wurden. Das Verhältnis der Zug- und Druckermüdungsfestigkeit zur Biegemüdungsfestigkeit wurde auch durch Untersuchungen bewiesen.

SALOKANGAS, J., *Die korrosionsbedingten Ermüdungsbrüche der Pleuelstangen bei Gattersägen*. Acta Polytechnica Scandinavica (Acta P. 251/1958). Mechanical Engineering Series 4, Helsinki 1958, 23 pp. Sw. Kr. 7:00 (Also The State Institute for Technical Research, Finland, Publication No. 43)

Das Pleuelstangenmaterial sowie die darauf beim Sägen einwirkenden Kräfte sind im Aufsatz behandelt worden. Die Berechnung liefert für die dynamische Beanspruchung der Pleuelstange den Wert $\pm 4 \text{ kp/mm}^2$; Messung mittels Dehnungsmessstreifen ergibt $\pm 5 \text{ kp/mm}^2$.

Es wird eine Statistik der in Finnland eingetroffenen Ermüdungsbrüche und Bruchansätze bei Pleuelstangen dargestellt.

Die Korrosionsermüdung im allgemeinen sowie die in den finnischen Sägewerken herrschenden korrodierenden Verhältnisse werden besprochen, mit dem Ergebnis, dass in den herrschenden Verhältnissen eine ungeschützte Pleuelstange mit Gewissheit binnen kurzem zum Bruch kommt. Es werden zahlreiche, durch Bilder erläuterte Beispiele der Korrosion sowie von Ermüdungsbrüchen und Bruchansätzen gegeben.

Es wird eine in Laboratoriumsverhältnissen ausgeführte Untersuchung des Fortschreitens eines Ermüdungsbruchs in einer solchen Pleuelstange dargestellt, die nach festgestelltem geringerem Ansatz zum Ermüdungsbruch kassiert worden war, Bild 10.

Es werden dem Schrifttum entnommene Angaben bezüglich des Schutzes der Pleuelstangen gegen Ermüdungskorrosion gemacht.

OLSSON, UNO, *Non-circular Bevel Gears*. (Acta P. 256/1959) Mechanical Engineering Series 5, Stockholm 1959, 224 pp. Sw. Kr. 14.00

Using similar methods, and as an extension of «Non-circular Cylindrical Gears», Acta Polytechnica No. 135 (1953), this investigation presents a method for designing non-circular bevel gears of any shape. The author has applied spherical geometry and spherical rolling curves, i.e. pitch curves on a spherical surface, instead of using solid geometry and the conception of rolling cones. It is shown that the spherical conic section curves can be used as pitch curves, if the shafts are placed at the foci. Mating curves to the spherical conic section curves (spherical conic section rolling curves) are then determined with varying dimensions between the axes of rotation.

If the desired pitch curve is divided into a convenient number of arcs, each arc can be replaced by an arc of a spherical conic section rolling curve. Formulae for finding the substitute arcs are deduced. Further formulae are developed for determining the pitch curve for the mating wheel, which also consists of arcs of spherical conic section rolling curves.

Finally, it is shown how the gear teeth may be cut by using circular milling cutters. Examples of the design of bevel gears are also given.

SALOKANGAS, J. and LEHTO, P., *On the Fatigue Strength of a Copper Coating Sprayed on Steel Bars*. Acta Polytechnica Scandinavica (Acta P. 258/1959) Mechanical Engineering Series 6, Helsinki 1959, 21 pp. Sw. Kr. 7:00 (Also State Institute for Technical Research, Finland, Publication No. 48)

A copper layer was sprayed on the surface of a steel test bar (Fig. 5, 6). The stress that could be sustained for 10^7 load cycles without producing a crack, visible under the binocular microscope, was regarded as the fatigue strength of sprayed copper. The effects that had occurred in the sprayed coating were examined under the binocular microscope during the fatigue test. On the basis of the observations made in the fatigue tests it could be stated that both the wire feed and the spraying distance were, within certain limits, inversely proportional to the fatigue strength of sprayed copper (Tables 4 and 5).

ASTRUP, Nils Christian: *Cavitation Erosion on Screw Propellers*. Acta Polytechnica Scandinavica (Acta P. 280/1960). Mechanical Engineering Series 7, Stavanger 1960. 16 pp. Sw. Kr. 7:00.

As an introduction the cavitation is defined and explained physically.

Erosion on ship propellers is described and some photographs are given.

The mechanics of cavitation is treated, reference to different experiments in hydraulic research and to mathematical theory being made.

Cavity shapes are defined hydrodynamically, and the appearance on the model screws are outlined and illustrated by photographs from cavitation tunnels.

Views are given on which type of cavitation in the water will give erosion on propeller blades, and an assumption is made on the effect of combined sheet and bubbling cavitation.

Principles are developed for design and for precautions to be made in order to avoid serious cavitation erosion.

AGERMAN, E.: *Notch Sensitivity in Steel*. Acta Polytechnica Scandinavica (Acta P. 288/1960). Mechanical Engineering Series 8, Stockholm 1960. 42 pp. Sw. Kr. 7:00.

(Also published in Asea Research 4, pp. 5—46, 1960.)

The fatigue strength of a machine part is reduced when its stress field is disturbed by fillets, grooves, holes etc. This phenomenon is called the notch effect and cannot be accurately calculated at the present time, but must be determined from experiments. A number of empirical formulae for calculating the notch effect have been published in the technical literature.

In this article an attempt has been made by statistical means to select the best of these formulae. In addition the author proposes a calculating method in which the safety factor is associated with the probability of fracture. The investigation clearly indicates the great importance of selecting accurately the experimental results on which the empirical formulae are to be based.

SALOKANGAS, Jaakko: *Über die Messung der Spannungsverluste in Stahl bei erhöhten Temperaturen*. Acta Polytechnica Scandinavica (Acta P. 298/1961). Mechanical Engineering Series No. 9, Helsinki 1961. 19 pp. Sw. Kr. 7:00. Finnish Contribution No. 22.

- 1) Es werden eingangs die Spannungen und ihre Relaxation besprochen.
- 2) Es ist eine Apparatur zum Messen der Auslösung von Spannungszuständen konstruiert worden, in welcher die gewünschte Formänderung bei gegebener Temperatur konstant gehalten und die zum Aufrechterhalten dieser konstanten Formänderung erforderliche Kraft in Abhängigkeit von der Zeit registriert wird.
- 3) Es ist die Auslösung von Spannungszuständen in Höhe von 5 kp/mm² und 10 kp/mm² bei kohlenstoffarmer Stahl im normalisierten Zustand sowie im normalisierten und anschließend im Betrag von 10 % bearbeitet bei den Temperaturen 150—550° C im Verlauf von 100 Stunden untersucht worden. Die Spannungen werden im bearbeiteten Stahl bei den höchsten Temperaturen bis herab zu etwa 200° C in weit stärkerem Grad als bei dem unbearbeiteten Stahl ausgelöst, während unterhalb etwa 200° C die Auslösung im unbearbeiteten Material etwas stärker ausfällt.
- 4) Von den Probestäben sind senkrecht zur Oberfläche Debye-Scherrer-Aufnahmen gemacht worden.
- 5) Die inneren Spannungszustände des bearbeiteten Materials vor und nach durchgeführtem Spannungsauslösungsversuch sind mit Hilfe eines Röntgeninterferenzverfahrens gemessen worden.

DRAMINSKY, P.: *Secondary Resonance and Subharmonics in Torsional Vibrations*. Acta Polytechnica Scandinavica (Acta P. 299/1961). Mechanical Engineering Series 10, Copenhagen 1961. 69 pp. Sw. Kr. 7:00.
Danish Contribution No. 13.

A theory of non-linear crankshaft vibrations is developed, fully considering the effects of impulse distortion and mass variation. A case of «secondary resonance» in a 10-cylinder engine is described and calculated. Representing the non-linearities as «fictive forces» acting on a linear system a great simplification of detail calculations is obtained.

APS Me 11

UDC 621.824-185.7:539.413:518.61

SALA, I.: *A Numerical Method for Calculating Critical Speeds of Rotating Shafts*. Acta Polytechnica Scandinavica (Acta P. 315/1962.) Mechanical Engineering Series No. 11, Helsinki 1962. 15 pp. Sw.Kr. 7:00.
Finnish Contribution No. 32.

The bending curve of a shaft is presented in the form of an integral equation of the second order. A number of distinct arguments are chosen a priori e.g. equidistant. Each of the corresponding ordinates can then be presented as a linear combination of all the others. This takes place by a so-called weighted mean method. The coefficients of these linear sums are rational expressions which have as factors the values of the flexural rigidity and the mass per unit length of the shaft at the distinct points. The eigenvalue of the linear homogenous system of equations mentioned above gives the critical speed of the shaft provided that the flexural rigidity is constant. In other cases by multiplying the matrices of two linear homogenous systems of equations one gets a matrix whose eigenvalue gives the critical speed in question. — This method is suitable for calculations performed with the Electronic Digital Computer. The accuracy of the result can be checked by performing the calculation with two or three different numbers of distinct arguments.

APS Me 12

UDC 624.073:539.3:534.121.1

SOLECKI, Roman: *Bending and Vibration of an Isotropic Rectangular Plate with a Hinged Slot*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 12, Trondheim 1962. 19 pp. Sw.Kr. 7:00.

A procedure is given to find the relevant static and dynamic quantities of an isotropic rectangular plate simply supported along the boundaries and having a slot parallel to one of the edges, but otherwise arbitrary in length and position. The external load is arbitrary, and it is assumed that the edges of the slot shall not come in contact with each other at any stage of the bending of the plate. The case of a hinged slot is also treated.

SOLECKI Roman: *Bending and Vibration of Non-rectangular Plates*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 13, Trondheim 1963. 20 pp. Sw.Kr. 10:—.

A procedure is given for the solution to the problem of harmonic vibrations including static loading of freely supported plates of a shape where two pairs of edges are parallel, but where the other edges may have any arbitrary shape.

Me 14

UDC 539.31:517.93

LINNALUOTO, Veikko: *Exact Solution in the 2-dimensional Case for the Anisotropic Beam*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 14, Helsinki 1963. 19 pp. Sw.Kr. 10:00.

In a previous report, a general mathematically exact solution has been derived for the anisotropic beam in the 2-dimensional case. The results have been directly obtained from the equilibrium and compatibility equations in a simple way without Airy's stress function. This is possible because one can assume that the form of the general solution is known from earlier investigations.

By comparison with Seewald's results for the isotropic beam some of his expressions are found to be erroneous.

Me 15

UDC 621.891.275:532.516.5

CHRISTENSEN, H.: *The Lubrication of Rolling Contacts. Measurement of Film Thickness*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 15, Trondheim 1963. 30 pp. Sw.Kr. 10:00.

The thickness of the oil film separating the working surfaces of such machine elements as gears, roller bearings, cams etc. is of the greatest importance for a successful operation of these elements.

A test machine, and a method for measuring the film thickness between heavily loaded rolling disks has been developed and has been used to measure the variation of film thickness between the disks as speed, inlet viscosity of oil and load was varied.

PERSEN, Leif N.: *On the Differential Equation of a Vibrating Beam Including the Effect of Inner Damping*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 16, Trondheim 1963. 30 pp. Sw.Kr. 10:00.

The differential equation for the lateral deflection of a vibrating beam has been deduced under certain specified assumptions. The material in the beam is supposed to exhibit a damping effect due to shear which is different from that due to normal stresses. No conclusive equation is obtained because it has been shown that the importance of several terms will have to be decided upon in each case. On the other hand it is believed that most influences on the differential equation of any importance have been brought to light.

WUOLIJOKI, J. and VAISANEN, S.: *Critical Speed of Shafts with Elastic Clamping Moment at the Bearings*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 17, Helsinki 1964, 31 pp. Sw.Kr. 10:00.

The critical speed of a solid bending shaft is studied, taking into account the shear deformation and the inertia effect of the rotary motion in the deflection plane. The endeavour has been made to make the end conditions of the bearing arrangement consistent with actual truth by assuming that at the supports a clamping moment is present, acting according to a coefficient of end restraint which may have any arbitrary value.

Formulae giving the critical speed have been derived for a shaft mounted on two supports and for a cantilever shaft, and graphs containing auxiliary curves have been plotted for the purpose of graphical determinations for certain slenderness ratios of the shaft. The study only comprises the first normal mode of the shaft and the gyroscopic effect has been neglected.

RANTA, Matti A.: *An application of Integral Transformations and the Wiener-Hopf Technique to the Supersonic Flow past an Oscillating, Nearly Circular, Slender Body*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 18, Helsinki 1964, 41 pp. Sw. Kr. 10.00.

In the previous report, a general slender-body solution has been derived for the linearized perturbation potential in a supersonic flow. The results have been obtained by means of integral transformations and the Wiener-Hopf technique.

Attention is paid to the discontinuities in the gradient of the potential, generally eluded. The influence of a body shape is taken into consideration. The accuracy of the results depends on the omitted terms when linearizing the boundary condition. The error increases along with the deviation from a circular form.

FLOBERG, LEIF: *On Hydrodynamic Lubrication with Special Reference to Sub-cavity Pressures and Number of Streamers in Cavitation Regions*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 19. Stockholm 1965, 36 pp. Sw. kr. 10.00.

Hydrodynamic lubrication of two lightly loaded rotating circular cylinders is studied. Special reference is here given to sub-cavity pressures and number of oil streamers in cavitation regions. It is shown both theoretically and experimentally how the sub-cavity pressure will influence the number of streamers and the other bearing quantities. The agreement between theory and tests is quite satisfactory. It is shown that the influence of the surface tension can be neglected even at extremely light loads.

Calculations are made for pressure distributions, load capacities, and oil flows.

Tests are carried out for pressure distributions, load capacities and meniscus locations. Photos are taken showing the cavitation boundaries.

Me 20

UDC 62-56

OHLON, R.: *Control problems associated with stable platforms using single-axis integrating gyroscopes*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 19, Stockholm 1965, 140 pp. Sw. kr. 20.00

The report is concerned with automatic control problems associated with platforms with three and four axes of freedom using singleaxis integrating gyroscopes in the stabilizing loops of the stable element. Special attention is paid to the dynamic interaction between the gimbal elements and the vehicle. The derived moment equations are general and can be used for other types of gimbal suspended elements.

Me 21

UDC 621.436.12.019.8

KURKI-SUONIO, ILMARI: *The spray impingement theory of ignition delay in small swirl-chamber diesel engines*. Acta Polytechnica Scandinavica. Mechanical Engineering Series No. 21. Helsinki 1965, 84 pp. Sw. kr. 10.00.

The paper is concerned with ignition delay in a high-speed swirl-chamber engine. The experimental part consists of ignition delay measurements with natural aspiration, and with throttling and supercharging covering an inlet pressure range of 0.6...1.4 kp/cm². Ignition delay measurements with variable fuel temperature have also been affected. Measurements were made using an instrumentation for which a high degree of accuracy is claimed.

In the theoretical part of the investigation, a review is given of present knowledge of the reactions of hydrocarbons leading to ignition. Existing ignition delay theories are presented and discussed. In accordance with the thermal theory of ignition, the author has derived an induction time equation for a case where the activation energy is divided among many degrees of freedom. A theory is presented, entitled the spray impingement theory, for the ignition delay. This theory is based upon existing observations of the combustion process. On the basis of this theory an empirical equation is proposed, and the test results compared with it. Finally there is a discussion of the effect of fuel preheating, oxygen content of the air and injection advance.

RANTA, MATTI A.: *On the integral transformation of the linearized perturbation velocity potential*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 22, Helsinki, 1965, 23 pp. Sw. kr. 10.00.

By application of the general theory of discontinuity in the field at the characteristic surface, evidence has been given that

1. In a steady flow the normal component of ∇u_1 is continuous, whereas the tangential one is not, Equations (16).
2. Potential φ is continuous, Equations (20) $\text{Grad } \varphi = 0$.
3. The normal component of velocity is discontinuous, Equations (19). $\text{Div grad } \varphi \neq 0$.
4. The tangential component of velocity is continuous, Equations (21) $\text{Rot grad } \varphi = 0$.

During the course of integral transformation in x, y -space the vanishing of the contribution due to discontinuity in the normal component of velocity, item 3, was proved by a new means based direct upon items 2 and 4, as well as upon the suitable change in variable of integration, Equation (28), and upon the differential equation of an envelope of characteristic surfaces, Equation (7).

The final result, Equation (33), is identical with that obtainable more directly by disregarding the discontinuities. In fact, there exists no discontinuity in the normal component of velocity, since the linearization of the perturbation velocity potential will imply a weak shock and consequently the pressure jump Δp will vanish, making $\text{Div grad } \varphi = 0$ as well.

BJERNINGER, SIGFRID: *Vibrations of Tractor Driver*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 23, Stockholm 1966, 122 pp. Sw. kr. 20.00.

The main part of the experimental investigation included field testing of the vibrations to which the tractor driver is exposed using different tractor seat designs, suspension and damping characteristics, tractors, ground and road conditions, and varying speeds. Laboratory experiments included testing the spring characteristics and the suspension dynamics of different seats, and also the possibilities of decreasing the vibration strains on the driver by choosing suitable seat suspension and damping. Seat design in other respects and the positioning of the seat were also studied.

The results from theoretical investigations were compared with those from the laboratory experiments and field tests. Among other things it was evident from these results that the suitability of the seat with regard to suspension and damping characteristics can be determined quite satisfactorily by determining the static spring characteristics and by drop tests. The correct combination of tractor and seat with driver can be tested by placing the tractor on a vibration machine with only the rear wheels on the uneven rollers.

The investigation has shed more light on the technical possibilities of decreasing the vibration strains to which tractor drivers are exposed. Guiding principles for the design and choice of tractor seats have been established.

KOSTILAINEN, V.: *A Pulsating Ship Screw Propeller Operating in Homogeneous Water Flow*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 24, Helsinki 1966, 103 pp. Sw. kr. 20.00.

This study is concerned with a new unsteady propulsion device, to be called a pulsating screw propeller. The device consists of an ordinary screw propeller, a cylindrical cam mechanism, and a double-acting working cylinder. The translational motion of the piston is transformed by means of the cylindrical cam mechanism into a combined translational and rotational motion. The translational and rotational velocities of this motion should be so related to each other that when the combined motion is transferred to the screw propeller, thrust is produced.

Equations of the motion of the system have been derived. By the application of a quasisteady state method of calculation, these equations have been solved numerically with the aid of a computer for several combinations of basic parameters. The computations and preliminary model tests have indicated the existence of very high instantaneous reaction forces in the cylindrical cam mechanism. By use of the dynamic programming of R. E. Bellman there was effected a partial optimization of the form of the groove of the cam cylinder, which resulted in considerably diminished reaction forces, and improved open-water efficiency.

CHRISTENSEN, HELGE: *Some experiments on „running-in” and scuffing of disks.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 25, Trondheim 1966, 37 pp, Sw. kr. 10,00.

Experiments have been carried out on a disk machine to study some aspects of „running-in” and scuffing.

It was found that the „run-in” process operates at a higher efficiency at the beginning of the test period. The attainment of 100 % asperity contact does not signify that scuffing is imminent. The rate of decrease of oil film thickness appears to have an influence on the severity of contact.

WUOLIJOKI, J. and VÄISÄNEN, S.: *Higher Modes of Critical Speed of Shafts with Elastic Bearing Moments.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 26, Helsinki 1966, 26 pp. Sw. kr. 10.00.

This paper is an extension of the authors' earlier paper, Critical Speed of Shafts with Elastic Moment at the Bearings (APS, Me 17, 1964). A study is made of the critical speed of a bending shaft, taking into account the shear deformation and the inertia effect of the rotary motion in the deflection plane. It has been assumed that a clamping moment is present at the supports and that this acts in accordance with a coefficient of end restraint which may have any arbitrary value. The study is concerned with the five lowest normal modes of the shaft.

Formulae which give the critical speed have been derived for a shaft mounted on two supports and for a cantilever shaft, and graphs containing auxiliary curves have been plotted with a view to graphical determination of certain slenderness ratios of the shaft.

THALIN, GUNNAR: *Calculation of Mobile Crane Booms.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 27, Stockholm 1966, 15 pp. Sw. kr. 10.00.

This article presents a new method of computing mobile crane booms. The calculation is merely analytical and more exact than hitherto used methods.

A diagram for determining effective lateral buckling length is given.

The magnifying factor of the bending moment from lateral forces on the boom top, due to bending moment from compressive force, is given in a formula. In order to determine the position of the most stressed boom section, a diagram is produced.

A comparison between computed and actually measured boom deflection of a U.S. made crane shows good accordance.

The permissible load, according to Swedish regulations, is computed for the above mentioned crane. This value turns out to be only a little more than 25% of the value given by the maker.

Using methods originally referring to symmetric load combination can be misleading.

Finally the author draws attention to a tendency with U.S. crane makers to decrease the safety factor against fracture to a level that does not seem to be realistic.

CAVELL, BO: *The axially loaded homogeneous cylindrical rubber spring*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 28, Stockholm 1967, 60 pp. Sw. kr. 10.00.

Rubber springs used in machine design are mostly subjected to large elastic deformations so the linear theory of elasticity is not valid. The relation between, for instance, force and elongation is often empirically determined, or a simple theory of linear elasticity is applied. This work gives the solution to the problem of an axially loaded homogeneous cylindrical rubber spring subjected to small as well as large elastic deformations. The axial load is assumed to be static. The end planes of the cylindrical rubber spring are bonded to metal plates and the cylindrical surface is free from external force. The theory of finite deformations is applied up to the second order approximation and five elastic constants characterize the material. Test to find the elastic constants and to verify the theory are carried out. The functions of displacement are given both in the linear theory and in the second order approximation. The related stresses, principal stresses and equivalent stresses are given according to the linear theory. The agreement between tests and theory is shown to be good between 25 % compression and 50 % tension.

ANDRÉASON, STAFFAN: *The pivoted slider bearing of infinite width considering variable viscosity, heat transfer and elastic and thermal deformations*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 29, Stockholm 1967, 44 pp. Sw. kr. 10.00.

This report deals with an analysis of the performance of pivoted slider-bearings of infinite width. Assuming the moving solid to be rigid and to have infinite heat conductivity, the influence of a two-dimensional temperature distribution upon the bearing characteristics is discussed. Taking into account heat conduction in the fluid as well as in the slider and using realistic thermo-hydrodynamic boundary conditions, elastic and thermal pad deformations and fluid viscosity variations due to temperature and pressure are included in the discussion.

HÅKANSSON, BENGT: *The infinite partial fitted journal bearing*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 30, Stockholm 1967, 21 pp. Sw. kr. 10.00.

This paper presents results of a theoretical investigation of the partial fitted journal bearing. For a given bearing angle and load direction relative to the bearing, it is found that there are two solutions which are compatible with the equations of equilibrium. One of these solutions is unstable and the other stable.

The load capacity, the load angle, the volume flow rate, the power loss, the temperature rise and the coefficient of friction are given in both tables and diagrams which also contain cavitation and stability borderlines.

KARLSSON, K. I. and PERMAN, S.: *Large steel tanks with ends of a special design*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 31, Stockholm 1967, 22 pp. Sw. kr. 10.00.

Using a developable surface a special design and a method of estimating the main stresses in the ends of a cylindrical tank have been presented. The existence of membrane stresses which, combined with a system of initial stress, allows for a higher internal pressure than that calculated, but still within the range of proportionality between load and deformation, has been shown by model tests.

Some elementary calculations regarding the influence of the design on the comparative weight of tanks have been made, some details of the design are shown and the method of erection is described.

LINDHARDT, PER: *Über die Stabilität der permanenten Drehungen einer Welle*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 32, Copenhagen 1967, 27 pp. Sw. kr. 10.00.

Die Behandlung der Stabilität permanenter Drehungen einer Welle wurde durch die Untersuchung von instabilen Torsionsschwingungen ergänzt.

Die Rechnung zeigt, dass Unwucht hervorgerufene Biegeschwingungen durch den Einfluss der äusseren Dämpfung unter Umständen Torsionsschwingungen einer Welle aufschaukeln können.

Die Rechnungsergebnisse konnten nur in den ausgesprochenen Fällen experimentell bestätigt werden.

Aufschaukelnde Torsionsschwingungen scheinen somit nur bei viel niedrigerer Eigenfrequenz für Torsionsschwingungen als im Maschinenbau gebräuchlich aufzutreten.

Übrig bleibt die physikalische Kuriosität, dass eine Welle vermöge des durch die Biegeschwingungen variierten Massenträgheitsmomentes um die Drehachse und des Friktionsmomentes mit ähnlichen Mitteln wie ein Tänzer pirouettenartige Bewegungen ausführen kann.

HELLAN, KARE: *Analysis of rectangular plates in stationary creep bending*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 33, Trondheim 1967, 16 pp. Sw. kr. 10.00.

The creep bending of a rectangular plate is investigated. A finite element method is used in an iterative procedure to obtain numerical results for a square plate under several conditions of loading and support. Various parameter values in the assumed constitutive law are considered.

SALA, ILMARI: *On the numerical calculation of the flexural critical speeds of a rotating multispan shaft.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 34, Helsinki 1968, 22 pp. Sw. kr. 10.00.

With reference to some of the author's former publications a brief presentation is given of an approximate method for determination of the critical speeds of a shaft with two bearings.

Thereafter it is elucidated how the method can be used for determination of the critical speeds of a continuous multispan shaft.

LJUNGSTRÖM, O.: *Air cushion vehicles (ACV) in water transport. A critical analysis of future possibilities and applications in Scandinavia.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 35, Stockholm 1968, 216 pp. Sw. kr. 30.00.

Based on amphibious ACV technology, development stage in 1966 and prospects for the next decade, possibilities for future civil transport ACV operations in Scandinavian waters are analyzed technically, economically and with due consideration of competition in the future transport market development.

State of the art in various aspects of ACV technology is reviewed. A critical analysis of ACV applications and operations is carried out, using a family of different size projected vehicles, and some transport system models, suitable for Scandinavia, as well as special market analysis methods for this case, of introducing a new means of transportation. Emphasis has been given to the most important marketing factors, such as transport economics and passenger attractivity, in relation to existing transport systems.

The transport economy evaluation includes a specially developed cost-parameter variance analysis. ACV-traffic, with passengers and cars, is studied for two different areas: archipelago traffic (Stockholm) and Baltic Sea routes Stockholm — Finland.

FLOBERG, LEIF: *On the ball flowmeter and the ball viscometer.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 36, Stockholm 1968, 28 pp. Sw. kr. 10.00.

The case of a ball in a tube filled with liquid is treated theoretically and generalized to apply to both of the two cases, when a ball falls in a tube or when the liquid is moving. The Reynolds lubrication theory is used to determine the conditions in the thin oil films between the ball and the tube wall. Thus the theory holds for small clearances relative to the ball radius.

It is shown that the ball rotates with different speeds at different eccentricities. The rotational speed is derived from equilibrium conditions of the ball, which conditions also tell us that all locations of the ball are unstable.

Continuity of flow gives the falling velocity of the ball or the oil flow passing the ball. This velocity is a function of the eccentricity.

Tests are made with a 2 inch steel ball falling in a tube filled with oil. The accordance between theory and tests is extremely good. Some photos of small cavitation regions are shown.

FLOBERG, LEIF: *Sub-cavity pressure and number of oil streamers in cavitation regions with special reference to the infinite journal bearing*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 37, Stockholm 1968, 35 pp. Sw. kr. 10.00.

This report treats the cavitation phenomenon in journal bearings when consideration is taken for sub-cavity pressures. The influence of sub-cavity pressures will be pronounced at low loads. The size of the sub-cavity pressures decides the number of oil streamers in the cavitation regions.

The mechanism of sub-cavity pressures is studied theoretically and experimentally. It is shown that the tensile strength of a liquid is dependent of the size of gas bubbles in the liquid and the surface tension. It is also shown experimentally that liquids can withstand pressures considerably lower than absolute vacuum.

How the sub-cavity pressures influence the behaviour of cavitation regions is shown for a journal bearing case of infinite width. The connection between the number of oil streamers in a cavitation region and the sub-cavity pressure is given. If the number of oil streamers is known, load capacities, oil flows, and the other bearing quantities can be determined.

SAMANTA, SHYAM K.: *The application of the upper bound theorem to the prediction of indenting and compressing loads for circular and rectangular discs*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 38, Stockholm 1968, 36 pp. Sw. kr. 10.00.

Limit analysis is applied to obtain upper bound loads for the solution of certain indentation and compression problems. The theories developed are based on the assumption that the deforming material has an infinite Young's modulus and non-work hardening. The assumption of a constant yield stress may not be seriously in error for many hot-working process and for many metals under cold and warm working conditions.

Upper bounds are obtained for plastic compression of a cylinder between two indenting dies, plastic compression of a circular disc between rough annular dies, free compression of an annulus between perfectly rough dies and plastic compression of a rectangular disc between rough parallel overhanging dies.

SAMANTA, SHYAM K.: *Theoretical analysis of the design of mechanical hammers for high-velocity forging*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 39, Stockholm 1968, 23 pp. Sw. kr. 10.00.

A theoretical analysis intended to facilitate the design of mechanical hammers for high-velocity forging is presented. The analysis is based on the assumption that the forging force is of the square-wave or the triangular-wave type for design purposes and is supported by experimental results.

OJALA, AITO: *The effect of exhaust pressure on the economy of condensing turbines at low cooling water temperatures.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 40, Helsinki 1968, 76 pp. Sw. kr. 10.00.

The effect of vacuum changes has been analysed on the basis of theoretically determined optimum conditions.

On examination of the optimum leaving velocity with respect to heat rate, it was found that vacuum improvement is utilisable for power generation only up to a leaving velocity considerably below the speed of sound. Optimum vacuum equations are given as well as curves for easy determination of the significance of design leaving velocity and diffusing section. The method developed for heat rate change determination will be of value in operation and design optimisation, as the method gives direct which part of the vacuum change can be utilized, and is uniformly suitable also for more complicated turbines. Vacuum values attained on 8 turbines in acceptance tests in Finland, and measurement results concerning change in heat rate, steam side pressure loss of condenser and condensate depression, are given.

Me 41

UDC 621.436.13.013.1

RYTI, M.: *Über die Darstellung der Spülung bei schrittweisen Rechnungen des Ladungswechsels von Zweitakt-Dieselmotoren.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 41, Helsinki 1969, 24 pp. Sw. kr. 10.00.

Modellversuche über den Spülverlauf haben gezeigt, dass die Vermischung zwischen der Spülluft und dem Restgas während der Spülung klein ist. Für schrittweise numerische Rechnungen des Ladungswechsels wurde ein mathematisches Modell aufgestellt, in dem keine Mischung stattfindet. Um den Verlauf der Gas-Zusammensetzung darstellen zu können, wurde eine Spülfunktion gewählt, welche die augenblickliche Zusammensetzung der aus dem Zylinder ausströmenden Menge in Funktion bekannter Größen angibt. Für das aufgestellte Gedanken-Modell wurde ein durch numerische Integration lösbares Gleichungssystem angegeben, welches bei allen durch die Spülfunktion charakterisierten Spülverfahren gleichermaßen anwendbar ist.

Me 42

UDC 621.822.57
532.516

LUNDHOLM, GUNNAR: *The circumferential groove journal bearing considering cavitation and dynamic stability.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 42, Stockholm 1969, 89 pp. Sw. kr. 10.00.

Hydrodynamic lubrication of the journal bearing with a circumferential oil groove is studied. The groove is fed with oil under pressure. Sub-cavity pressures are neglected and the viscosity is assumed to be constant. The calculations cover variations of the width-to-diameter ratio, relative eccentricity, and oil groove pressure. The locations of the cavitation regions are found by applying boundary conditions which guarantee continuity of oil flow. Routh's stability condition is used for the investigation of the dynamic stability. Load capacity, power loss, oil flow and stability borderlines are given in design charts, from which a bearing with minimum relative power loss and with stable running can be designed. Tests have been made for load capacities, attitude angles, shapes of the cavitation regions, and stability borderlines.

RANTA, MATTI A.: *On the application of perturbation technique to the study of missile flight*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 43, Helsinki 1969, 43 pp. Sw. kr. 10.00.

For the stability of missiles in rectilinear flight with an arbitrary inclination, special attention is paid to some secondary factors usually neglected. They are: the diminishing mass of the missile; the mass flow inside the missile; the imperfections in the resulting thrust called malalignments; and the effect of gravity. The treatment is based on the perturbation method applied to Euler's equations of motion, and on the Laplace transforms and the Wiener-Hopf technique. The stability criterion is derived from the approximate solution for small values of time. A numerical example is given.

STÖRAKERS, B.: *Finite creep of a circular membrane under hydrostatic pressure*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 44, Stockholm 1969, 107 pp. Sw.kr. 20.00.

A theoretical and experimental investigation of creep of a circular membrane under one-sided hydrostatic pressure is presented.

Exact governing equations for finite deformations are derived and solved in linearized form for steady state and transient primary creep. Approximate solutions including tertiary creep are given and discussed.

Tests of membrane creep offer a possibility to study fundamental aspects of flow and rupture properties for a material under biaxial stress. Experimental equipment and methods of measurement for this purpose are described in detail. It is shown that a membrane test offers some advantages before an ordinary uniaxial test from the viewpoint of obtaining material creep data.

Results from tests of a Mg alloy are presented and compared with theoretical predictions. It is shown that also physically caused tertiary creep and brittle creep rupture may be predicted within a decent degree of accuracy by a phenomenological approach. It is concluded though that to achieve a deeper understanding of creep-induced material deterioration, theories based on more obvious physical observations are needed.

FLOBERG, LEIF: *On the optimum design of sector-shaped tilting-pad thrust bearings*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 45, Stockholm 1969, 36 pp. Sw.kr. 10.00.

This report deals with the sector-shaped plane tilting-pad thrust bearing. Numerical data are presented for load capacities, load locations, oil flows, and power losses. An optimum design analysis is made, which shows how to design a bearing with minimum of power loss. A schedule for design calculation is presented. For given values of load capacity, angular velocity, and minimum permissible oil film thickness, the optimum number of pads is determined. The calculations are made for constant viscosity. Tables and charts of bearing quantities are given.

HELLAN, KARE: *Analysis of rectangular plates in transient creep bending*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 46, Trondheim 1969, 20 pp. Sw.kr. 10.00.

The transient creep bending of a rectangular plate is investigated. A finite element method is used in an iterative procedure to provide numerical results for the square plate. Various parameter values in the assumed constitutive equation are considered.

LEINONEN, TATU E.: *On the influence of slight curvature in the bending behaviour of a rotating shaft*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 47, Helsinki 1969, 39 pp. Sw.kr. 10.00.

Many scientists have studied the problem of stability in a rotating shaft. In each of these studies, a shaft with zero initial curvature has been assumed. This dissertation extends the classical theory by taking into account a slight curvature of the shaft. The slight curvature is approximated by a finite Fourier series. A theoretical model is developed which illustrates the behaviour of the shaft during rotation. It is observed that the solutions from this model are unique except at discrete values of the rotation speed. Two special cases from this general theory are considered in detail. Finally a practical method for estimating the maximum bending moment is presented. An example of its application to a shaft design problem is given.

VÄISÄNEN, SEPPO K.: *On the critical speed of a shaft as influenced by the supports*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 48, Helsinki 1969, 56 pp. Sw.kr. 10.00.

A study is made of the critical speeds of a shaft with non-zero mass supported at both ends when the elastic displacements of the bearings (transversal as well as in slope) are assumed to be non-linear. The general deformation equations, which are valid both in respect of flexural vibration and of various composite rotatory motions, are derived by applying the expressions presented by TIMOSHENKO. Dampings are neglected.

The cases of non-linear bearing conditions do not lead to a linear eigenvalue problem as do the ideal and linear cases. In order to find an approximate solution of the problem, the amplitude of deflection of the shaft corresponding to each speed of rotation is considered to be critical at which the amplitude in question exceeds a given allowable deflection which is maximal e.g. from the viewpoint of operation of the machine, or at which alternatively the marginal stress exceeds a given, dangerous value.

The computer programme used here is applicable in determining the combined effect exerted on the deflection and marginal stress of the shaft by the transversal and slope elasticities, consistent with elasticity graphs of arbitrary shape, of bearings of various types and of their supports.

SAMANTA, S. K.: *Dynamic deformation of aluminium and copper as a thermally activated process*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 49, Stockholm 1970, 24 pp. Sw.kr. 10.00.

The steady-state flow stress, σ , at high strain-rate, $\dot{\epsilon}$, and at elevated temperatures, T , of commercial purity aluminium and copper was analysed using the theory of the thermally activated deformation of metals. The data for aluminium is shown to fit the relationship

$$\dot{\epsilon} = A_1 \exp(\beta \sigma) \exp\left(\frac{-Q}{RT}\right) \quad \text{and} \quad \dot{\epsilon} = A_1 [\sinh(\alpha \sigma)]^{n_2} \exp\left(\frac{-Q}{RT}\right)$$

for copper

where A_1 , A_2 , α , β and n_2 are constants, and it was concluded that dynamic compression is a thermally activated process. The experimental activation energy, Q , for aluminium was determined to be 37.2 Kcal/mole and for copper to be 74 Kcal/mole. The experimental activation energy for aluminium is slightly higher than that observed both for creep and self-diffusion but for copper it is much higher than that observed both for creep and self-diffusion. Discussion for the observed discrepancy is given in the paper.

PERSSON, S. A.: *Vertically welded fillet welds*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 50, Stockholm 1970, 40 pp. Sw.kr. 10.00.

This report describes vertical upward and downward welding in fillet joints. Results are presented from welding with nine different electrodes in heavy plates of three different grades. Direct comparisons concerning the static strength and welding costs have been made between different test welds. In addition, hardness measurements and assessment of the structure have been carried out. The report contains recommendations for the performance of vertical downward fillet welding.

PERSSON, H. A., and GNEDBORN, K. E.: *Utilisation of the penetration for fillet welds*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 51, Stockholm 1970, 83 pp. Sw.kr. 10.00.

The report treats the possibilities of achieving in practice penetration with fillet welds. The strength of submerged-arc welded joints is assessed. The possibilities of checking the penetration are discussed. Rules for the utilisation of the penetration are presented.

MÄRTENSSON, N.: *On the influence of the rate of deformation at cold processing*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 52, Stockholm 1970, 57 pp. Sw.kr. 10.00.

Time variance of tool displacement and material strain during plastic forming in presses and hammers is analysed. Existing experimental techniques for the determination of forming parameters are criticized. Compression tests on cylindrical steel specimens confirm the observations made. To study the influence of strain-rate on stress at large strains, a method is developed using hydrostatic rod-extrusion through a curved die designed to give a constant strain-rate. Obtained results are discussed.

WENNERSTRÖM, ERIK: *Stresses in external involute spur gears*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 53, Stockholm 1970, 63 pp. Sw.kr. 10.00.

Contact and bending stresses in external involute spur gears are treated. Non-dimensional parameters based on equal centre distance and equal torque on the pinion are derived. These parameters are suitable for an optimum analysis showing the advantage of using modified gears.

Numerical solutions of the plane elastic problem of a gear tooth is also presented. From one solution the principal stresses and their differences are calculated, and plotted. These theoretical fringes are compared to a photoelastic test. The agreement between theory and experiment is very good. Theoretical stress concentration factors have been calculated and compared to earlier known experimental stress concentration factors.

Fatigue tests showed good agreement with calculated contact pressures and given material properties.

A gear breakage test also verified the tangential stresses at the fillet curve.

PHYSICS INCLUDING NUCLEONICS SERIES

APS Ph 1

UDC 534.154:612.789

FANT, C.G.M., *Modern Instruments and Methods for Acoustic Studies of Speech*. Acta Polytechnica Scandinavica (Acta P. 246/1958), Physics Including Nucleonics Series 1, Oslo 1958, 83 pp. Sw. Kr. 7:00 (Also in the Proceedings of the VIII International Congress of Linguists, Oslo 1958)

The report summarizes techniques of studying speech by means of acoustic analysis and synthesis with special emphasis on recent developments at the Royal Institute of Technology, Stockholm, aiming at processing of large quantities of speech at low cost. The basic relations between articulation and speech wave are discussed, and methods of spectrographic and oscillographic analysis and classification of the essential signal structure of speech sounds are exemplified.

Acoustic correlates to vowel quality, stress, juncture, and word accent are discussed. Speech synthesis is described briefly with emphasis on instrumentation developed in Sweden.

APS Ph 2

UDC 537.311.33

STUBB, T., *The Measurement of Conductivity in Semiconductors with the Aid of Microwaves*. Acta Polytechnica Scandinavica (Acta P. 259/1959), Physics Including Nucleonics Series 2, Helsinki 1959, 14 pp. Sw. Kr. 7:00 (Also State Institute for Technical Research, Finland, Publication No. 47).

With the complex conductivity $\delta_c = \delta_r + j\delta_i$ as a starting point the loss angle for a semiconductor has been given. The impurity scattering and the scattering resulting from lattice vibrations have been taken into account.

Conductivity and resistivity have been determined by measuring the loss angle of the semiconductor in the 3 cm band. The method permits the said quantities to be measured without any such contacts as have to be applied to the sample in D.C. measurements of conductivity. The method employs disc-shaped samples, which are easy to manufacture.

In the measurements reported here, a silica sample having a resistivity of 10 ohms · cm was used.

APS Ph 3

UDC 537.311.33

STUBB, I., *Untersuchung über die Lebensdauer der Minoritätsträger in Germanium*. Acta Polytechnica Scandinavica (Acta P. 269/1960) Physics incl. Nucleonics Series 3 (Also The State Institute for Technical Research, Finland, Publication no. 49). Helsinki 1960. 17 pp. Sw. Kr. 7:00.

Die Lebensdauer des Minoritätsträgers hat man mit stabförmigen Proben untersucht. Man hat festgestellt, dass die gemessene Volumenlebensdauer $\frac{1}{\tau_v}$ vom Radius abhängig ist. Die Messungen mit verschiedenen Ätzlösungen sind an den von demselben Kristall geschnittenen Proben ausgeführt worden. Hierbei hat man die Einwirkung der verschiedenen Lösungen auf die Oberflächenkombination feststellen können. Mit einer WAG Lösung hat man das beste Resultat erhalten, wenn die Anfangstemperatur der Lösung + 35° C ist.

ROOS, Matts: *Approximate gamma ray flux calculations outside a reactor core*. Acta Polytechnica Scandinavica (Acta P. 273/1960) Physics including Nucleonics 4, Helsinki 1960. 25 pp. Sw.Kr. 7:00.

Several methods are discussed for manual calculation of the gamma ray flux outside the cylindrical core of a heterogeneous thermal reactor with cylindrical rod fuel elements. The relative effects of various approximations are investigated, concerning the homogeneity of the core, the geometry, the source distribution and energy spectrum. It is concluded that one particular method is best suitable for computing machine programming.

APS Ph 5/I

UDC 536.662
536.722

HÄRLIN, A.: *Elementary Analysis and Heat Value*. Acta Polytechnica Scandinavica (Acta P. 275/I/1960), Physics including Nucleonics 5/I, Stockholm 1960. 14 pp. Sw. Kr. 7:00.

Concerning the relation between the analysis of a combustible substance consisting of coal, hydrogen and oxygen solely and its calorimetric heat value a considerable number of formulæ have been published from time to time. The simplest ones have the form $K_b = c \cdot C + h \cdot H - o \cdot O$ (kcal/kg), where C, H and O are percentages of their quantities.

c	varies between	80.8	and	84
h	<	<	287	< 345
o	<	<	0	< 43

Other formulæ have a more complicated structure.

From about 600 analyses published in different contexts, the following equation has been deduced

$$K_b = 82 C + 280 H - 29 O + 200$$

This appears to be superior to other formulæ. The next best one has the following form

$$K_b = (78.6 + 2.8 \sqrt{100 - C}) C + 270 H - 270$$

Some sixty analyses published lately agree well with the first formula deduced above.

APS Ph 5 II

UDC 536.662
536.722
662.99

WIDELL, T: *Enthalpy Diagrams for Flue Gases*. Acta Polytechnica Scandinavica (Acta P. 275/II 1960) Physics including Nucleonics Series 5, Stockholm 1960. 14 pp. Sw. Kr. 7:00.

Many technical combustion calculations, especially rough estimates, refer to the relation between the heat effect developed during combustion and the heat transfer from flue gases at different temperature changes.

The calculations can be made very easy by means of a diagram showing the relation between enthalpy of the combustion air and of the gases and the lower heat value of the fuel.

Such diagrams have been worked out for firing with coal, wood, peat, town gas and producer gas. The limits of error are usually $\pm 1\%$.

The use of the diagrams is demonstrated with examples.

CYVIN, Sven J.: *Mean Amplitudes of Vibration in Molecular Structure Studies*. Acta Polytechnica Scandinavia (Acta P. 279/1960). Physics including Nucleonics Series 6, Trondheim 1960. 226 + 6 pp. Sw. Kr. 21:00.

A comprehensive treatise on the mean amplitudes of vibration for interatomic distances in molecules. 137 references are cited. The mentioned quantities may be obtained by electron-diffraction on one hand, and spectroscopic calculations on the other hand. The earlier work in this field is surveyed, and the spectroscopic calculations based on the assumption of small harmonic oscillations are studied in detail. Numerical computations are reported for a number of molecules: BF_3 , cyclopropane, cyclopropane- d_3 , NO_2 , GeCl_4 , and others.

A new approach to the problem is proposed, "the mean-square amplitude quantities" being employed. These quantities are defined as the mean values of $S_i S_j$ for arbitrary coordinate pairs and have in many aspects similar properties to those of the familiar force constants.

JENSEN, Erling: *General Theory on Spin Echoes for any Combination of any Number of Pulses. Introduction of a simple "Spin-Echo Diagram"*. Acta Polytechnica Scandinavica (Acta P. 283/1960). Physics including Nucleonics Series 7, Copenhagen 1960, 20 pp. Sw. Kr. 7:00

The effects of diffusion damping of spin-echo amplitudes were first treated by E. L. Hahn. An improvement of Hahn's averaging procedure was suggested by T. P. Das and A. K. Saha. Their theory, however, as is shown here, contains an error. This is corrected, and the revised theory is shown to give for a special case the same result as obtained by different methods by H. I. Carr and E. M. Purcell and by H. C. Torrey. Furthermore the revised theory is extended to account for any combination of pulses, and it is shown that the results are conveniently summarized in a simple "spin-echo diagram".

MØRCH, K. A.: *Measurement of Total Acoustic Power of Sources of Sound in a Reverberation Chamber*. Acta Polytechnica Scandinavica (Acta P. 286/1960). Physics including Nucleonics Series 8, Copenhagen 1960. 25 pp. Sw. Kr. 7:00.

The report summarizes the theory of the reverberant sound field, and an account of the reverberation chamber investigations at the laboratory is given. The reverberation chamber is to be used for measurement of the total acoustic power of sources of sound. Investigations have been carried out at frequencies between 2 and 15 kc/s.

JÄSKELÄINEN, P.: *On Microwave Conductivity, Noise and Oscillations of Gas Discharge Plasma*. Acta Polytechnica Scandinavica (Acta P. 291/1960). Physics including Nucleonics Series 9, Helsinki 1960. 24 pp. Sw. Kr. 7:00. Finnish Contribution No. 19.

A discharge tube having a gas filling identical with that of fluorescent lamps was matched to a helical slow wave structure in the 25 cm band. The noise temperature of the system was determined on the basis of attenuation measurements from the electron temperature of the plasma, neglecting the quantum effects and the shot noise, which is generally permissible for continuous plasma in the microwave range.

The measured attenuation curve revealed a maximum attributable to the discharge plasma. Its connection with the maximum of the real part of the plasma conductivity derived by Margensau was studied.

Moving striations occurred occasionally in some of the tubes. In such instances a special luminous phenomenon was observed at the anode, by which the presence of oscillations could also be ascertained with the unaided eye.

FORWALD, H.: *Wave Phenomena in Compressed-Air Ducts*. Acta Polytechnica Scandinavica (Acta P. 292/1961). Physics including Nucleonics Series 10, Stockholm 1961. 149 pp. Sw.Kr. 14:00. Swedish Contribution No. 12.

After treating the basic equations for the theory of elastic waves, the author describes the wave phenomena occurring in conjunction with the rapid filling and discharge of ducts with compressed air. Wave experiments — mainly intended to provide information for the designing of air-blast circuit-breakers — are described and the results are graphically reproduced. The treatise has been supplemented by a historical and bibliographical survey of the research work into waves in compressible media.

STUBB, T. *The Measurement of the Hall Effect with the aid of Microwaves in Germanium Specimens Changing from n-type to p-type with Changing Temperature*. Acta Polytechnica Scandinavica (Acta P. 294/1961). Physics Including Nucleonics Series 11, Helsinki 1961. 18 pp. Sw. Kr. 7:00. Finnish Contribution No. 20.

By means of measurements of the Hall effect in the 3 cm band with various germanium specimens, an absorption has been found at 240°K. This absorption is due to transition of the sample from n-type to p-type with temperature. It could also be shown that the Hall mobility is proportional to $T^{-2.33}$ and that the measured ionization energy is well consistent with the value for Al, which is also the known doping material in the specimens.

TIURI, M: *Investigations of radio reflections from satellite-produced ion trails using 100 Mc CW radars.* Acta Polytechnica Scandinavica (Acta P. 295/1961). Physics Including Nucleonics Series 12, Helsinki 1961. 47 pp. Sw. Kr. 7:00. Finnish Contribution No. 21.

The occurrence of satellite-produced ionization has been studied on 100 Mc, with CW and pulse radar observing the transits of Sputnik III close to the latitude circle 65° N between August 1959 and April 1960. Certain echoes observed with the radar have been shown to be produced by the ion trail of the satellite. The ion trail echoes have been obtained only when auroral ionization has been present and when spread-F has occurred in the ionospheric soundings close to the observation site. The echoes have had an average duration of 2.5 seconds; the corresponding radar cross section at a distance of 700 km has been of the order of magnitude of 1000 square meters.

The observations seem to show that the reflection from the satellite-produced ion trail on 100 Mc is specular. On the basis of the radar cross section found, and the duration of the echoes, some estimates of the ion density and shape of the ion trail have been made.

APS Ph 13

UDC 537.311.33

STUBB, T. and GREAFFE, R: *A Study of the Quantum Efficiency on Absorption of an x-ray Radiation in a p-n Junction.* Acta Polytechnica Scandinavica (Acta P. 302/1961). Physics Including Nucleonics Series 13, Helsinki 1961. 19 pp. Sw. Kr. 7:00. Finnish Contribution No. 24.

The quantum efficiency of the photoelectric effect was determined by measuring the short-circuit current delivered by a specially designed germanium diode when its carriers were excited with x-rays. An x-ray tube with Cu anode was employed and the background radiation was eliminated with the aid of a Ni filter so that the approximate assumption of monochromatic radiation could be made.

The quantum efficiency was found to be 0.18 for 1.54 \AA wavelength.

The life span of the carriers in the diode was determined with the aid of a method involving pulse technics.

APS Ph 14

UDC 536.7:621.1.018.2

RIESEL, Hans: *Die thermodynamischen Zustandsgrößen des Wasserdampfes bei maschinellen Berechnungen.* Acta Polytechnica Scandinavica (Acta P. 306/1961). Physics including Nucleonics Series No. 14, Stockholm 1961, 20 pp. Sw. Kr. 7:00. Swedish Contribution No. 15

Es werden ausgehend von einer Zustandsgleichung des trockenen Wasserdampfes, Annäherungen angegeben, die sich für die Berechnung der thermodynamischen Zustandsgrößen des Wasserdampfes mit elektronischen Rechengertäten eignen. Weiter wird für nassen Wasserdampf eine neue Gleichung für den Adiabatenexponenten κ abgeleitet. Zusätzlich werden zweckmässige Gleichungen für den Zustand des flüssigen Wassers angegeben. Die Zahlenwerte der Koeffizienten aller angegebenen Gleichungen sind für das Technische Mass-system berechnet. Weiter ist für κ eine Tabelle für Überhitzten sowie für nassen Wasserdampf angegeben.

SIMONS, L., SPRING, E., WENDT, G.: *Excited states of Pr^{192}* . Acta Polytechnica Scandinavica (Acta P. 309/1961) Physics including Nucleonics Series No. 15, Helsinki 1961, 31 pp. Sw.Kr. 7:00.
Finnish Contribution No. 27.

Measurements have been made of gamma-gamma angular correlations for transitions in Pr^{192} following β -decay of Ir^{192} . Our measured correlation function of the 468-316 keV cascade is in agreement with previous measurements and confirms the assignment of spin 4 to the 784 keV level. By measuring the 300-300 keV correlation and the 600-300 keV correlation we are able to assign a spin of 3 to the 921 keV level. The correlations of the 600-300 keV, 598-613 keV and 885-316 keV cascades require a spin of 4 for the 1201 keV level. A measurement of the correlation of 1065-316 keV cascade allows either spin 3 or spin 4 for the 1381 keV level. Thus the levels at 613 keV, 921 keV and 1201 keV have spins 2, 3 and 4 respectively. Data on β -decay of Ir^{192} and multipoles of the gamma rays suggest that these levels have positive parity. From this and other evidence we argue that these levels form a rotational band with $K=2$ based on the gamma-vibrational level at 613 keV.

LAURILA, E.: *On the Fields and Permanent Magnets in Magnetic Pulleys and Separators*. Acta Polytechnica Scandinavica (Acta P. 312/1962). Physics including Nucleonics Series No. 16, Helsinki 1962, 26 pp, Sw. Kr. 7:00.
Finnish Contribution No. 29.

Calculations have been made of the most common periodic magnetic fields as they appear in magnetic systems with magnetic separators and pulleys. Special attention has been paid to the pulling action of different fields. Furthermore, consideration has been given to the different ways in which systems can be designed for the production of periodic fields in plane or cylindrical arrays by the employment of permanent magnets. It is clearly shown that in systems in which the pole distance is small in comparison with the overall dimensions of the system, the best performances are achieved by the utilization of the highest possible $(BH)_{\text{max}}$ -value. However, in cylindrical pulleys with circular poles, the use of anisotropic ceramic magnets offers great advantages. As regards pulling action, the performances obtained are competitive with electromagnetic pulleys.

SIMONS, L., WENDT, G. and SPRING, E.: *On the decay of Hf^{177}* . Acta Polytechnica Scandinavica (Acta P. 314/1962) Physics including Nucleonics Series No. 17, Helsinki 1962, 22 pp. Sw.Kr. 7:00.
Finnish Contribution No. 31.

In investigations of the angular correlations of the 72 keV - 250 keV cascade in Hf^{177} , the following result has been obtained:

$$W(\Theta)_{\text{exp}} = 1 - (0.122 \pm 0.017) P_4(\cos \Theta) + (0.013 \pm 0.028) P_6(\cos \Theta)$$

Furthermore, previously made measurements of spectra and angular correlations have been re-investigated. These investigations have confirmed the level scheme for Hf^{177} previously proposed, the spins and parities of the energy levels, and the multipoles of the gamma rays. For the 72 keV radiation, we obtained an upper limit of 0.1 per cent M2 in the E1 + M2 transition.

ERÄMETSÄ, Olavi: *The principles of visual measurements*. Acta Polytechnica Scandinavica (Acta P. 317/1962). Physics including Nucleonics Series No. 18, Helsinki 1962, 31 pp, Sw. Kr. 7:00. Finnish Contribution No. 33.

In this report of an investigation the general theory of visual measurements is presented. The equation which describes the dependence of the visual threshold phenomena on the illumination is also presented. On the basis of this equation, the formulae necessary in practical measurements are given. In the test made, a correlation between the parameters of the formulae and the typology of Kretschmer became apparent.

VARSILA, Kari: *The Effect of the Plutonium Conversion on the Prompt Temperature Coefficient of TRIGA*. Acta Polytechnica Scandinavica (Acta P. 321/1962.) Physics including Nucleonics Series No. 19, Helsinki 1962, 22 pp, Sw. Kr. 7:00. Finnish Contribution No. 34.

This work considers some of the reactor-physical aspects of TRIGA Mark II, a zirconium-hydride moderated and water-cooled research reactor, which has 20 per cent enriched uranium as fuel. The moderating properties of crystalline zirconium hydride were calculated first. The effect of plutonium conversion on the prompt temperature coefficient of TRIGA has been studied theoretically, using two-group theory. For this purpose, the temperature dependent cross sections were evaluated over a wide range of fuel temperature. The time-dependent behaviour of fuel and poison concentrations has been calculated, and evaluated over the life of the core when the power level is at 100 kW.

Some of these calculations were made on an Elliot 803 computer, and the results are presented both numerically and graphically.

STENMAN, Folke: *A Transistorized Anticoincidence Analyser for Radiocarbon Dating*. Acta Polytechnica Scandinavica (Acta P. 322/1962). Physics including Nucleonics Series No. 20, Helsinki 1962, 18 pp. Sw.Kr. 7:00. Finnish Contribution No. 35.

A description is given of a fully transistorized anticoincidence analyser for low-level counting. Its function is based on the linear properties of a certain type of monostable multivibrator fed with an input pulse which is longer than its normal output pulse. The unit is built for a maximum counting rate of about 500 pulses/sec., and accepts input pulses with a wide range of amplitude and duration. There is a discussion of its applications to C^{14} -dating work. In an appendix there is suggested an alternative method for determining errors in the activities measured.

CYVIN, Sven J.: *Elementary Treatment of Secular Equations with Special Reference to some Problems in the Theory of Molecular Vibrations*. Acta Polytechnica Scandinavica Physics including Nucleonics Series No. 21, Trondheim 1963, 11 pp. Sw.Kr. 10:00.

The methods of secular equations and characteristic vectors are treated in a simple mathematic way, with special attention to secular equations of low orders. The description is confined to some special problems of spectroscopy: The Wilson GF matrix method in the study of molecular vibrations, and (B) Mean and Polo's C matrix method for treating the Coriolis interaction of rotation-vibration.

Ph 22

UDC 539.173.8:546.36

SIMONS, L. et al.: *Gamma-gamma directional correlations in Ce^{140}* . Acta Polytechnica Scandinavica. Physics including Nucleonics Series No. 22, Helsinki 1963, 35 pp. Sw. Kr. 10:00.

The excited levels in Ce^{140} have been investigated by studying the decay of La^{140} . Intensities have been determined from gamma ray spectra and the results are 328 keV (19%), 435 keV (0.4%), 490 keV (44%), 635 keV (< 1%), 733 keV (5%), 818 keV, (22%), 874 keV (5%), 927 keV (9.5%), 1120 keV (~ 1%), 1597 keV (100%), 1680 keV (1%), 2355 keV (0.5%), 2535 keV (4%), 2820 keV (0.15%) and 3100 keV (< 1%). Weak peaks were found at 120 keV, 135 keV, 178 keV, 240 keV and 270 keV, the intensities were less than 2%.

From the results of gamma ray, coincidence and sum spectra a decay scheme for Ce^{140} is proposed.

Angular correlation measurements of eight cascades were carried out and they gave the following spin sequence 1597 keV, 2+; 1902 keV, 0+; 2090 keV, 4+ (3-); 2350 keV, 1+ or 2+; 2410 keV, 3+ (2+); 2520 keV, 2+; 3280 keV, 2 or 4.

Ph 23

UDC 533.9.621.372.829.3

JÄÄSKELÄINEN, P. M. P.: *On attenuation and electrical length of a plasma loaded helical transmission line*. Acta Polytechnica Scandinavica. Physics including Nucleonics Series No. 23, Helsinki 1963, 53 pp. Sw.Kr. 10:00.

The attenuation and electrical length of a helical slow-wave structure were determined at about 1300 Mc as a function of the d-c current of a low-pressure Hg-Ar discharge tube inside the helix, and without external magnetic fields. The plasma conductivity and electron density were determined by the cavity resonance method, using Margenau's conductivity formula.

An anomalous behaviour was revealed both in the attenuation and electrical length as function of discharge current. Reasons for the discovered phenomena were considered. A theory of the plasma loaded helical line was developed, using the sheath helix approximation. Numerical solution was effected with the aid of an electronic data machine.

JENSEN, O.: *Note on the Influence of Variable Viscosity on the Critical Rayleigh Number*. Acta Polytechnica Scandinavica. Physics including Nucleonics Series No. 24, Trondheim 1963. 00 pp. Sw.Kr. 10:00.

For a fluid contained between two plane perfectly conducting surfaces, the theoretical critical Rayleigh number is well known when the viscosity of the fluid is constant. The influence of variable viscosity on the Rayleigh number has so far only been found in a special case. This influence is in this paper calculated for more realistic boundary conditions.

LAURILA, E. A.: *On the measurement of the susceptibility and conductivity of the rock surrounding a bore*. Acta Polytechnica Scandinavica. Physics including Nucleonics Series No. 25, Helsinki 1963, 24 pp. Sw.Kr. 10:00.

A simple theoretical model is here used as a basis for consideration of the possibility of measuring the magnetic susceptibility and the electric conductivity of the rock surrounding a bore by the aid of AC methods.

A suitable form of the AC-sonde is shown to be a lengthened coil with an axis perpendicular to the bore. At low frequency AC, the impedance of the coil is dependent only on the susceptibility of the surrounding material. A bore hole susceptibility meter based on this idea works very well when used in the evaluation of the ore content of the rock. A high frequency device, known as a Murometer, simultaneously indicates the subceptibility and conductivity. However, in practice, its use is confined to special cases, in particular because its response to granulated ore is quite different from that of ore in bulk.

TUNKALO, E.: *On Determination of the Time-dependent Pair Correlation Function from Inelastic Scattering Measurements of Slow Neutrons at a Fixed Angle*. Acta Polytechnica Scandinavica. Physics including Nucleonics Series No. 26, Helsinki 1963. 18 pp. Sw. kr. 10:00.

An attempt has been made to evaluate the time-dependent pair correlation function of an assembly of atoms from measurements of inelastic neutron scattering at a fixed angle. The method employed is based on the assumption that the classic pair correlation function is Gaussian, of which the time-dependent width is determined by fitting the measured distributions in energy of the scattered neutrons at 90 degrees, after allowing first for the detailed balance factor.

The method was applied to the case of scattering by water. The results obtained display behaviour which is correct quantitatively for short time intervals and at least qualitatively for longer periods.

HELLAN, Kåre: *A Study of the Damping Properties of Metals*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 27, Trondheim 1963. 39 pp. Sw.Kr. 10:00.

Based upon highly idealized physical concepts, an attempt is made to express quantitatively the damping properties of metals during vibration. The purpose of the investigation is to explain some experimental facts related to damping, and to furnish a reasonable basis for the engineering design of vibrating parts.

LILJA, R. and STUBB, T.: *A Study on the Dielectric Constant and Resistivity of Amorphous, Polycrystalline and Monocrystalline Selenium at 24 GHz*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 28, Helsinki 1964, 32 pp. Sw. Kr. 10.00.

Resistivity and dielectric constant of thin semiconductor samples have been measured by means of a microwave bridge. Necessary calculations are based on a perturbation theory.

Measurements have been carried out on amorphous, polycrystalline and single crystal selenium. Results indicate that the resistivity of crystalline selenium has a positive temperature coefficient at the measuring frequency, 24.029 GHz. The dielectric constant ϵ_r of single crystal selenium, measured parallel to the crystal c-axis was found to be 20 at $+20^\circ\text{C}$, increasing to 28 at $+183^\circ\text{C}$.

SIMONS, L. SPRING, E. KÄLD, L. JUNGNER, H. HOLMBERG, P. and FORSBLOM, I.: *An Investigation of the $K^{39}(p,\gamma)Ca^{40}$ Reaction at Proton Energies 1103 keV, 1131 keV and 1153 keV*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 29, Helsinki 1964, 19 pp. Sw. Kr. 10.00.

A study has been made of the gamma-ray spectra of the resonances at proton energies 1103 keV, 1131 keV and 1153 keV in the $K^{39}(p,\gamma)Ca^{40}$ reaction, and the main decay features are given. We have found evidence supporting the existence of a new Ca^{40} level, with an energy at about 4.70 MeV. Measurement was made of the angular distribution of the 9.44 MeV gamma-ray de-exciting the 1131 keV resonance level. The spin and parity of the resonance level is probably 1^+ or 1^- .

Ph 30

UDC 532.526.4

BRAND, R. S. and PERSEN, L. N. *Implications of „the Law of the Wall“ for Turbulent Boundary Layers*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 30, Trondheim 1964, 61 pp. Sw. Kr. 10.00.

The scope of the paper is to show that if the existence of a universal law of the wall can be proved, this may be used as sufficient information to formulate a unified approach to all turbulent boundary layer flows. The law of the wall replaces the phenomenological relation between the stresses and the strain rates. The formulation of the law of the wall given by Spalding has been used to treat several cases of turbulent boundary layer flows.

Ph 31

UDC 532.5.013.4:532.516

BRAND, R. S.: *On the Stability of Plane Parallel Flows*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 31, Trondheim 1964, 15 pp. Sw. Kr. 10.00.

The possibility of predicting the stability of solutions of the Navier-Stokes equations with respect to local disturbances by means of Liapunov's method is discussed. Both the energy of the disturbance and the square of the vorticity are considered as possible Liapunov functions. It is shown that, in plane parallel flows, the growth or decay of the disturbance depends only on the disturbance itself and not on the main flow.

Ph 32

UDC 539.184.2:539.122.17:546.815

SPRING, E: *Triple Coincidence and Correlation Measurements of Gamma Rays from Pb^{208}* . Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 32, Helsinki 1964, 22 pp. Sw. kr. 10.00.

Gamma transitions in Pb^{208} have been investigated by double and triple coincidence measurements. Two new transitions, 0.275 MeV and 0.552 MeV, starting from the 3.720 MeV energy level, have been established. The spin of the 3709 keV energy level is either 4^- ($\delta \sim +0.35$) or 5^- ($\delta \sim -0.15$) according to the measurements of double and triple angular correlations. δ is the multipole mixing parameter of the 0.511 MeV gamma transition.

HANSEN, ERIK BENT: *Higher Order Diffraction by a Circular Disk*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 33, Copenhagen 1964, 47 pp, Sw. kr. 10.00.

An asymptotic solution of the problem of diffraction of a spherical acoustic wave by a circular disk when the ratio between the radius of the disk and the wave length is very large has been obtained previously by the author (reference (1)). In the present paper this solution is extended to include more terms of the asymptotic expansion of the field at observation points in the geometrical optics shadow region. The degree of approximation makes it possible to verify the results for the circular disk which have been obtained by J. B. Keller from his geometrical theory of diffraction, by R. N. Buchal and J. B. Keller from their boundary layer theory of diffraction, and also some extensions of their calculations which are derived in the present paper. The results comprise the first and the second term of the field associated with singly or doubly diffracted rays and the first term of the field associated with any multiply diffracted ray. Both a soft and a hard disk has been considered but only when the source is on the axis of the disk.

INGEMANSSON, S. and SÖDERQUIST, J.: *Computation of Equal-Noise Contours for Aircrafts*. Acta Polytechnica Scandinavica, Physics Including Nucleonics Series No. 34. Stockholm 1965, 40 pp. Sw. kr. 10.00.

In 1956 an expert committee was appointed in Sweden to investigate aircraft noise problems. During the work of the committee a method was developed to compute the noise in the vicinity of a starting aircraft.

With knowledge of aircraft data and climb path data the sound level in dB(A) is calculated for distances up to 10.000 meters from the flight path of turbojet and propeller aircrafts.

In this way the width of equal-noise contours [curves encircling areas in which the sound level exceeds certain values, say 70, 75 100 dB(A)] is calculated. The equations have been coded for computer-processing.

The calculation method for turbojet aircraft has been checked by flight noise measurements at Malmslätt in 1958. Flight noise measurements have also been performed in 1956 (military turbojet aircrafts) and in 1959 (propeller driven transport airplanes).

PERSEN, LEIF N.: *Heat-transfer through Turbulent Boundary Layers at arbitrary Prandtl-number*. Acta Polytechnica Scandinavica. Physics including Nucleonics Series No. 35, Trondheim 1965, 47 pp, Sw. kr. 10.00.

The theory of heat-transfer through turbulent boundary layers is treated based on the concept of a universal temperature-profile. The paper is a natural sequence to Ronald S. Brand and Leif N. Persen: "Implications of 'the Law of the Wall' for Turbulent Boundary Layers". Acta Polytechnica Scandinavica Ph 30. Trondheim 1964.

LAURILA, ERKKI and SAIRIO, EINO: *A Borehole Susceptimeter*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 36, Helsinki 1965, 22 Sw. kr. 10.00.

The most complete information on the properties of a rock is given by diamond drilling whereby the drill core can be studied and analyzed. Pneumatic drilling is much less costly than diamond drilling, but no well determined sample is obtained by it, only the continuously outflowing slurry; this can be analyzed of course which at least gives some information on the chemical composition of the rock. It is therefore desirable to develop methods which are able to give information concerning the rock surrounding the borehole. A number of devices of this kind exist, each based on different physical phenomena. One class of these instruments covers devices for determining the susceptibility of the rock, a well-known example of which is the OKI-permeameter [1]. One of the authors has already touched on this problem [2]. In this paper, a new borehole susceptimeter will be described, the design of which is based on the theoretical considerations given in the above mentioned paper. The development of this susceptimeter is based on broad practical experience gained in the Jussarö mines and described by Strandström et al. [3].

PESONEN, JUUKA: *Measuring permanent magnet materials by yoke methods*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 37, Helsinki 1966, 18 pp. Sw. kr. 10.00.

A survey is given of the general yoke methods applied in the testing of permanent magnet materials, along with a description of a simple device, incorporating a standard laboratory magnet and two hall elements, which automatically records hysteresis loops of highly coercive materials.

TUNKALO, EINO: *Construction and Performance of a Cold Neutron Source*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 38, Helsinki 1966, 48 pp. Sw. kr. 10.00.

The description is presented of a cold neutron source installed in a tangentially piercing beam tube of the FİR 1 reactor of Institute of Technology, Otaniemi. The moderator chamber is given a "black body radiator"-like geometry in order to enhance the moderation of neutrons. The coolant is separated from the moderator to enable use of different liquids as moderator and coolant.

The influence of the moderating material and temperature as well as of the shape and size of moderator is discussed. Cryogenic and safety considerations are also presented. The performance of the cold neutron source is given in terms of the intensities and spectra of emerging neutrons. Methane (at 78° K) and liquid hydrogen (at 20° K) are as moderators giving an intensity of 6.7×10^7 neutrons/sec and 1.3×10^7 neutrons/sec for the beryllium filtered beam 3×4 cm².

PERSEN, LEIF N.: *Über die Grundlage der Theorie für Wärmeübertragung durch turbulente Grenzschichten*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 39, Trondheim 1966, 24 pp. Sw. kr. 10,00.

Die Theorie der Wärmeübertragung durch turbulente Grenzschichten wird aufgestellt indem als einzigen phänomenologischen Relationen die universellen Geschwindigkeits- und Temperaturprofile eingeführt werden. Die in dieser Weise einheitlich aufgebaute Theorie stimmt mit den Versuchsdaten gut überein.

JAUHO, P. and AALTONEN, R.: *Pulsed neutron measurements in graphite*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 40, Helsinki 1966, 18 pp. Sw. kr. 10.00.

Pulsed neutron experiments in graphite are considered both theoretically and experimentally. The existence of a critical buckling in a crystalline, solid moderator is anticipated and only sizes larger than those corresponding to the critical buckling are used in the analysis. The diffusion parameters obtained for a 1.69 g/cm³ reactor grade graphite are:

$$\begin{aligned}\langle v \Sigma_a \rangle &= (54 \pm 20) \text{ s}^{-1}, \\ D_0 &= (1.99 \pm 0.06) \cdot 10^4 \text{ cm}^2/\text{s}, \\ C &= (15.9 \pm 4.0) \cdot 10^5 \text{ cm}^4/\text{s} \text{ and} \\ L_{II} &= (2.39 \pm 0.07) \text{ cm}.\end{aligned}$$

The local decay constants as a function of the delay time from the beginning of the neutron pulse show a pronounced plateau only in the event that the decay constant for the asymptotic mode does not exceed a value of about 2600 s⁻¹. This indicates the possible validity of Corngold's theorem even in the case of a crystalline solid.

WILNER, BERTIL: *On a spectroscopic method for measuring the electron temperature of a plasma*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 41, Stockholm 1966, 45 pp. Sw. kr. 10.00.

The derivation of the electron temperature of a plasma from measured spectral-line intensities is discussed for a wide temperature and density region. The theory is based on a simple analysis of different types of excitation and ionization equilibria as well as their relaxation times. Special consideration is given to the influence of step-wise processes or a non-Maxwellian electron-velocity distribution. The results are illustrated in a number of diagrams.

GRAEFFE, R. and HELESKIVI, J.: *Measurements of space charge limited currents in hexagonal selenium single crystals*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 42, Helsinki 1966, 30 pp. Sw. kr. 10.00.

A study has been made of space charge limited currents in hexagonal selenium single crystals. Measurements were effected of transient phenomena, the influence of crystal length on space charge limited currents, and the potential distribution in selenium crystals.

The findings are not in accord with the simple theory for space charge limited currents in a homogeneous semiconductor crystal, but are explicable by virtue of the model with thin high-resistive zones, proposed by Stuke.

SÖDERQUIST, BERTIL: *Measurement of biaxial creep strains using the moiré method*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 43, Stockholm 1966, 29 pp. Sw. kr. 10.00.

An instrument to investigate the biaxial strain field in a plate under creep conditions has been developed and tested. The design makes use of the moiré effect. Thus, a dense orthogonal array of shallow etch pits is produced on the polished surface of the test specimen. The image of this array is focused onto the ground glass of the instrument. When a line reference grating on a transparent base is superimposed upon this image, moiré fringes result. These can be recorded by a commercial camera for later analysis of the strains. The magnification of the instrument can be varied for convenient fringe setting. The sign of the strain at a given point may be found by rotation of the reference grating about the optical axis.

The instrument described above is being used to study the strain fields in holed thin plates of magnesium alloy during creep at elevated temperatures subjected to biaxial tensile stresses. This has not been done previously because conventional techniques (e.g. use of strain gauges) may not readily be applied.

LAURILA, ERKKI: *On the measurement of the magnetic susceptibility of anisotropic materials*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 44, Helsinki 1967, 17 pp. Sw. kr. 10.00.

This paper contains a description of a method of measuring the susceptibility tensor of an anisotropic magnetic material. It is shown that in practice, this is done most simply with spherical samples. There is also presented the design of a simple machine for making spheres of ore samples.

LINDERSTRØM-LANG, C. U.: *A model of the gas separation in a Ranque-Hilsch vortex tube*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 45, Copenhagen 1967, 24 pp. Sw. kr. 10.00.

An explanation is offered of the origin of the gas separation effects obtained with a certain class of vortex tubes. This explanation is based on a model which assumes centrifugation to be the primary cause of the separation and axial flows to determine the sign and magnitude of the net separation effect measured at the outlets.

Quantitative results of the model, calculated on the basis of a flow dynamic study of the tubes, are compared with the experimental values.

HOLMBERG, PETER: *Internal pair formation of the 1835 keV gamma ray in ^{88}Sr* . Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 46 I, Helsinki 1967. Parts I and II, 28 pp. Sw. kr. 10.00.

A study has been made of the internal pair formation of the 1835 keV gamma ray transition in ^{88}Sr by application of a triple coincidence method. The internal pair formation coefficient I' was determined as $(2.5 \pm 0.8) \times 10^{-4}$.

HOLMBERG, PETER: *Radiative widths for dipole and quadrupole transitions in $20 < A < 40$ nuclei*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 46 II, Helsinki 1967. Parts I and II, 28 pp. Sw. kr. 10.00.

A study has been made of radiative width in $20 < A < 40$ nuclei; it was found that $|M|^2 = 2.4 \times 10^{-2}$, 6.0×10^{-4} , 1.5×10^{-1} and 7.9×10^{-2} as average values for M1, E1, E2 and M2 transitions, respectively. In even-even selfconjugated nuclei $|M|^2 = 7.0 \times 10^{-2}$, and 6.3×10^{-3} for M1-radiation, if the transition proceeds to the ground state or to the first excited state, respectively. If each of the nuclei is treated as a single unit, a strong mass-dependence in $|M|^2$ is observed.

UHLENIUS, ROBERT and KIVALO, PEKKA: *An apparatus for determination of the B^{10} -isotope content.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 47, Helsinki 1967, 18 pp. Sw. kr. 10.00.

An apparatus for the determination of B^{10} -isotope content is described. The method adopted is based upon neutron transmission measurements, and is relative in nature, making use of two standard samples. The components of the electronic system and the counters are commercially available. The analyser is to be used in connection with the FIR-1 nuclear reactor of Triga Mark II type. The measurements are effected with solid samples, and the results achieved are in close accord with those derived from mass spectrometric analysis.

HÖGLUND, BERTIL: *Pencil beam survey of radio sources between declinations $+18^\circ$ and $+20^\circ$ at 750 and 1410 MHz.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 48, Stockholm 1967, 74 pp. Sw. kr. 10.00.

A survey with the 300-foot telescope of the National Radio Astronomy Observatory, Green Bank, W. Va., USA, at 750 and 1410 MHz has yielded 458 radio sources. The flux densities have been calibrated against the flux of 3C 264. The median spectral index for all sources in the survey is -0.76 . For sources near the galactic plane it is -0.54 and for Spur sources -1.13 . A separate discussion of spectra is given for sources where additional Cambridge data at 38 and 178 MHz, and Parkes data at 408, 1410, and 2650 MHz, are available. Source counts give a $\log N - \log S$ relation departing from a straight line. Comparison with 4C-data suggests that this effect is real.

Appendices give theoretical treatments of 1) reduction of noise fluctuations obtained in the smoothing of the data, 2) fluctuations of the background radiation level due to weak, unresolved sources, and 3) the influence of receiver noise on the derived values of the various source parameters.

BLOMBERG, C.: *Some fundamental aspects of many-body problems in statistical thermodynamics.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 49, Stockholm 1967, 162 pp. Sw. kr. 20.00.

Many-body problems in both classical and quantum statistical mechanics are here studied from a fundamental point of view. For this aim distribution functions and Green functions are used. These functions obey certain equations which accomplish the basic starting-point. The equations are simplified by introducing generating functionals. We can then get solutions in terms of functional integrals, which, at least in classical mechanics, can provide qualitative understanding of physical properties such as condensation. In all studied cases it is found that the equations give a fundamental nonuniqueness to the solutions and that perturbation theories in general only have an asymptotic meaning. It is also found that certain solutions give the properties of superfluid Bose- and Fermi-systems. The methods provide the possibilities of getting more general situations than those ordinarily studied. Finally it is shown how the properties of a metal can be described when all kinds of particle- and phonon-interactions are taken into account. These properties are given as "renormalized" properties obtainable from the knowledge of the ground state.

HJELT, SVEN-ERIK: *The transient field of a conducting permeable sphere in a uniform external field.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 50, Helsinki 1968, 22 pp. Sw. kr. 10.00.

The transient secondary field of a conducting permeable sphere in a uniform primary field changing stepwise has been calculated. The rate of change or the slope of the transient field can be used to distinguish between spheres of different conductivities irrespective of their magnetic properties. The absolute value of the transient field at the moment when the primary field has its greatest value can be used to distinguish between spheres of different magnetic permeability irrespective of their conductivities, provided that the volume of the spheres is kept constant.

Ph 51

UDC 539.382:539.434.013.3

SÖDERQUIST, B.: *Creep under equal biaxial loading of a disk with a circular hole.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 51, Stockholm 1968, 61 pp. Sw. kr. 10.00.

Thin disks of a magnesium alloy provided with a circular hole have been tested in equal biaxial tension under creep conditions at 240°C and 280°C. The strain distributions have been recorded throughout the test at suitable intervals using the moiré method. Uniaxial creep and rupture tests on specimens machined from the same batch as the biaxial specimens are also presented.

The known theoretical solutions for the biaxial steady-state case based on the criteria of Odqvist and Tresca have been compared with experiment. Both approaches yield roughly the same normalized tangential strain rate distributions for moderate values of the normalized radius. The radial strain rates due to Odqvist agree well with experiment, but those of Tresca comply with experiment only for moderate testing times and low stresses. However, both approaches may yield grossly inaccurate values as assessed by measurements of the tangential strain rate at the hole boundary.

Ph 52

UDC 539.125.5.162.2:546.48
539.125.5.164

PALMGREN, A.: *Measurements of the cross section of cadmium for neutrons in the 10 μ eV range.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 52, Helsinki 1968, 62 pp. Sw. kr. 10.00.

The feasibility of a new type of chopper for ultra low energy total cross section measurements has been demonstrated by a measurement of the cross section of Cd for neutron energies 7.5 and 9.1 μ eV corresponding to 104.6 and 94.8 Å wavelength respectively. Transmission samples are attached to the rotor which spins the samples with velocities as high as 300 m/sec in a cold neutron beam. The difference in velocity between the neutrons and the samples is very small. The samples are situated in slots at the periphery of the rotor. Neutrons enter and leave a slot through a narrow slit; in the rotating coordinate system the neutron paths are closed curves. The rotor thus also performs a velocity selection with 2.5 % resolution (fwhm). The relative velocity resolution is 20 %.

The neutron optical properties of the system, and the design of the rotor are discussed. A description of the experiment is given. The measured cross section values agree reasonably well with the Breit-Wigner values when $\sigma_0=8,000$ b, $\Gamma=112$ meV, $E_0=176$ meV.

SÖDERQUIST, BERTIL: *Creep rupture under uniform radial tension of a disk with a circular hole*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 53, Stockholm 1968, 36 pp. Sw. kr. 10.00.

A theoretical and experimental study has been carried out where a disk with a circular hole has been subjected to radial tension under creep conditions. The initiation and progression of cracking has been analyzed based on Kachanov's original postulates, using the approaches of Odqvist and Tresca, for the case of quasi-steady or stationary stress states during the progression of cracking. First and second order approximations to the large deformation approach using Tresca's flow criterion are included. The results of an experimental study on thin disks of a magnesium alloy are detailed. Although exhaustive quantitative comparisons not could be attempted due in part to experimental difficulties, the general trend of the data confirms the theoretical predictions. In particular, the radial direction of the observed cracks points to a maximum tensile stress criterion for crack initiation. A simple way of calculating the final rupture time is indicated corresponding to the rupture time produced by the applied stress.

SUONINEN, E.: *The average adsorption of monochromatic x-rays as a function of particle size in multiphase systems*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 54, Helsinki 1968, 24 pp. Sw. kr. 10.00.

An expression is derived for the average value of transmission of radiation through a sheet consisting of identical spherical particles embedded at random in a matrix of another phase, the absorption properties of the two phases being different. The result is a function of the sheet thickness, volume fraction of the spheres, absorption properties and the sphere diameter. If the other quantities are known, the diameter can be determined from a measurement of the average transmission.

The disturbing effect of local variations of the sheet thickness can be reduced by measuring the ratio of the transmissions at two wavelengths.

The method is applied to the determination of the average diameter of spherical particles of lead in brass by measuring the average transmission of Cu K α and Mo K α radiations. The results are in qualitative agreement with microscopic observations and indicate the effect of the annealing conditions on the sphere size.

STØREN, SIGURD: *Analysis of spherically and cylindrically divergent stress pulses in linear viscoelastic solids*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 55, Trondheim 1968, 36 pp. Sw. kr. 10.00.

Four different linear viscoelastic models, namely the Standard Linear Solid, the generalized Maxwell Solid, the "Constant loss tangent" Solid and the Kelvin-Voigt Solid are analysed. The dilatational wave velocity and attenuation coefficient for the different models are compared.

Fourier analysis is applied to the divergent stress pulse problem in spherical and cylindrical geometries, and the effect of the different damping models on the propagating pulse is discussed.

It is shown that the simple "Constant loss tangent" model gives a pulse shape almost identical to that of the more realistic generalized Maxwell model. The choice of a particular model, however, is not very important in this problem, because the propagating pulse is carried by amplitudes in a very narrow frequency range.

TUOMI, T. O.: *Photoconductivity of hexagonal selenium single crystals*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 56, Helsinki 1968, 38 pp. Sw. kr. 10.00.

A barrier model of photoconductivity for hexagonal selenium single crystals is presented. The model is based on the recombination of the current carriers at the dislocations in small angle boundaries. These have been observed by the Guinier-Tennevin method. The theory is compared with experiment by measuring the electronic thermoelectric power, the phonon drag and the recombination dependent photoconductivity phenomena in detail. The unusual dependence of the photoconductivity on the light intensity, the extremely slow decay curves are in agreement with the calculations. A typical value for the barrier at the dislocation is found to be 0.8 eV whereas the effective barrier of the small angle boundary is 0.14 eV. The hole-capture cross section for the center at the dislocation is found to be about 10^{-17} cm².

GHILDYAL, C. D. and PERSEN, LEIF N.: *On the turbulent swirling inlet flow in a circular pipe*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 57, Trondheim 1968, 48 pp. Sw. kr. 10.00.

The paper contains an attempt to investigate the turbulent swirling inlet flow in a circular pipe by means of Spalding's formulation of the law of the wall. The law of the wall has been used successfully for the axial flow without swirl, and an attempt is made to adapt the same law of the wall for the velocity boundary layer which will be created by the swirling motion. The paper is purely theoretical and no attempt has been made to compare these results with experimental evidence because such evidence is not known to the authors.

SÖDERQUIST, BERTIL: *Some aspects of creep and creep rupture*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 58, Stockholm 1968, 16 pp. Sw. kr. 10.00.

An alternative derivation of Rabotnov's creep relations (Rabotnov 1963) is presented which reduces the number of arbitrary exponents to two (n and v in the sense of Norton and Kachanov). A modification to Kachanov's multiaxial creep damage equations is proposed which links damage and stress in all principal stress directions where tensile stresses exist. Application to a previously studied problem (creep of a holed disk under uniform tension) shows that the noted discrepancy between theory and experiment concerning the tangential creep rate does not derive from the aspects of creep studied in this paper.

BUSCH, NIELS E., FRIZZOLA, JOHN A. and SINGER, IRVING A.: *The micrometeorology of the turbulent flow field in the atmospheric surface boundary layer*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 59, Copenhagen 1968, 45 pp. Sw. kr. 10.00.

The Monin-Obukov hypothesis for turbulent flows in thermally stratified surface boundary layers is discussed. The hypothesis is applied to the one-dimensional turbulent velocity spectra, thus providing a frame of reference for the comparison of spectra measured at various heights and sites and under a variety of stability conditions.

A recent analysis of spectral data taken under thermally neutral and unstable conditions is presented. When plotted in similarity co-ordinates the longitudinal velocity spectra show no sign of dependence on stability. The spectra of the vertical velocity component obey similarity theory for moderate thermal instability and agree well with the analytical expression suggested by Busch and Panofsky (1967). The lateral velocity spectra show stability, terrain and height effects.

HJELT, SVEN-ERIK: *On the half-plane model in double-dipole electromagnetic prospecting*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 60, Helsinki 1968, 41 pp. Sw. kr. 10.00.

Starting from Wesley's half-plane solution, a simple matrix formulation of the secondary field is found for systems, where the receiver is situated inside the transmitter loop or very close to it. The expressions include 9 antenna combinations and the dip and strike angles of the half-plane. Scale model experiments show negligible differences when compared with theoretical calculations.

The height dependence of the secondary field in double-dipole prospecting is $1/h^3$. Measurements made at two different heights give the depth of ore. The conductivity-thickness product can then be estimated from the frequency response. Estimates for the dip, strike and width of a dyke can be found using well-known techniques of interpretation. The best practical antenna system has a horizontal transmitter loop and a rod receiving antenna inside the loop with its axis in the direction of antenna system motion.

KALLI, HEIKKI and JAUHO, PEKKA: *On the derivation of new approximations for the monoenergetic Boltzmann equation using a self-adjoint variational principle*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 61, Helsinki 1968, 14 pp. Sw. kr. 10.00.

This paper demonstrates an application of the self-adjoint variational principle for the derivation of new approximations for the monoenergetic Boltzmann equation in the neutron transport theory. The criticality problem of a bare homogeneous one-dimensional slab reactor is used as an example. A trial function with one free parameter k is chosen, the respective approximation is derived and solved with various k -values and the critical half-thicknesses are compared with the results of the ordinary S_n approximations. In the appendix some results for the one-dimensional spherical reactor are listed.

HELESKIVI, J., PILVIÖ, O. and STUBB, T.: *Etch pit observations in trigonal selenium single crystals*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 62, Helsinki 1969, 16 pp. Sw. kr. 10.00.

The (1010) and (0001) planes of trigonal selenium single crystals grown from the melt were studied by optical microscopy after chemical etching. The results are compared with the barrier model presented to explain the electrical properties of selenium. On the (1010) planes, small angle boundaries produced during crystal growth have been observed. On the surface of a heavily worked crystal completely polygonized structure has been observed. The size of the polygons is well consistent with the distance between potential barriers estimated by electrical methods.

IHANTOLA, HEIKKI: *Punch-through controlled surface to increase breakdown voltage of planar p-n junctions*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 63, Helsinki 1969, 36 pp. Sw. kr. 10.00.

A new multiple guard ring (MGR) structure around the planar p-n junction is discussed. Utilizing controlled punch-through action between the guard rings the surface limited and the junction curvature limited breakdowns can be limited, and the device breakdown voltage can be made to approach the bulk breakdown of the plane p-n junction. The findings from numerous experiments have been classified, and the measured characteristics have been found to be in agreement with the presented theoretical model. The initiation of the punch-through action between the rings can be calculated; most of the other parameters are so manifoldly interrelated that their quantitative estimation was not attempted. Using small distances between the rings it has been possible to measure directly the ring potentials. The stability problems of the MGR structure have been discussed. The maximum obtained breakdown voltage at relatively small devices has been 1200 V.

SUOSARA, EERO and von BOEHM, JUHANI: *Application of group theory to trigonal selenium for OPW-calculations*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 64, Helsinki 1969, 22 pp. Sw. kr. 10.00.

A short review of group theory in energy band calculations is given. A method for calculating characters of non-symmorphic space groups is given and applied to selenium. A simple method for producing symmetrized orthogonal plane waves and their matrix elements is introduced for selenium and other non-symmorphic space groups, whose rotational parts form a diedric group.

PESSA, M., AKSELA, S. and KARRAS, M.: *The performance of an electrostatic cylindrical spectrometer in analysis of non-relativistic electron energies*. Physics including Nucleonics Series No. 65, Helsinki 1969, 14 pp. Sw. kr. 10.00.

An electrostatic cylindrical spectrometer was constructed and tested with an electron gun. The resolution was experimentally studied vs. the slit width. The results were finally compared with the calculations at the resolution range of 0.06—0.26 % (FWHM). The dependence of the electron energy on the deflecting voltage between the cylinders was measured and found linear at the tested interval of 100—2500 eV.

ODENÖ, H.: *Transient thermal stresses in discs with a temperature dependent yield stress*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 66, Stockholm 1969, 24 pp. Sw. kr. 10.00.

Equations are given for determining transient thermal stresses in a heat-treated disc. The material of the disc is assumed to be elastic-perfectly plastic, with a temperature dependent yield stress. The temperature is assumed to vary only in the radial direction. Application is made to the determination of stresses which arise when the rim surface of the disc is subjected to a rapid temperature increase. The stress distribution sequence and residual stresses are calculated for certain values of temperature increase and heating rate. In the numerical analysis the yield stress is assumed to be linearly temperature dependent.

ARHO, RISTO: *The lifetime of satellite 1958 α 1 (Explorer 1)*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 67, Helsinki 1969, 16 pp. Sw. kr. 10.00.

In 1960 the decay of Explorer 1 was predicted to July 1962. In 1968 King-Hele et al. gave for the total lifetime roughly 11 years indicating the decay early in 1969.

The error of the first lifetime determination was due to lack of knowledge of the effect of solar activity on atmospheric density.

In this investigation the lifetime was predicted 26 October 1968. The prediction indicated the decay in May 1970. An error analysis gives an inaccuracy of 90 days. The attained result thus notably differs from the result of King-Hele et al., whose inaccuracy is due to overestimating the solar activity maximum of 1968—1969.

An amendment of King-Hele et al. dated 15 January 1969 gives for the decay date May 1970, which is consistent with the result of this paper.

ÖHMAN, G. A.: *Numerical calculation of steady heat transfer from a horizontal cylinder by combined free and forced convection.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 68, Helsinki 1969, 26 pp. Sw.kr. 10.00.

The steady heat transfer by combined convection around a long horizontal cylinder has been studied at Prandtl number 0.73 in the intervals $0 \leq Gr \leq 5000$ and $-40 \leq Re \leq 40$, where Gr is the Grashof number and Re the Reynolds number, which is considered negative in the case when the free and forced convection act in opposite directions. An iterative finite-difference method is developed and programmed for automatic digital computation. Mean Nusselt numbers, local Nusselt numbers and velocity and temperature fields are obtained for a number of combinations of Gr and Re . The two steady vortices, which appear on the rear side of a cylinder in a transverse flow, are shown to be highly sensitive to free convection effects. Comparisons are made with other theoretical and experimental studies, and relatively close agreement is shown.

HEMILÄ, S.: *Non-ohmic effects in hexagonal selenium single crystals.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 69, Helsinki 1969, 42 pp. Sw.kr. 10.00.

The effect of an electric field on the conductivity of hexagonal selenium single crystals has been studied using crystals grown by various methods. Conductivity transients occurred when the field was changed, and these transients depended strongly on illumination. In every crystal studied the low field conductivity during the decay of photoconductivity could be quenched by applying a higher field, both at 300°K and at 80°K. In every crystal these effects started at very low fields, below 100 V/cm, but their amplitude varied considerable from crystal to crystal. Still stronger non-ohmic effects were observed at 80°K in the dark, e.g. a steady state characteristics $I \sim U^n$ was observed with $n \approx 3$. Some pulse measurements were also carried out. This non-ohmic behavior is a bulk effect and seems to be caused by crystal imperfections native to selenium. An electric field both increases the conductivity and increases the recombination rate of holes in Se single crystals. Results obtained at room temperature and in illuminated crystals also at lower temperatures can be interpreted by using a dislocation recombination model earlier applied to the photoconductivity results of Se.

HIISMÄKI, P.: *Back-reflection of neutrons from mosaic crystals.* Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 70, Helsinki 1970, 36 pp. Sw.kr. 10.00.

For calculating the transmission and reflection probabilities of neutrons impinging on mosaic crystals normal to a set of lattice planes a new technique has been developed based on the invariant imbedding approach for solving the underlying monoenergetic transport equation of strongly angle-dependent scattering cross-sections. The initial value problem resulting has been solved numerically with a digital computer for the (111)-reflection of Al. The results of the calculations have been compared to an experimental curve measured with a thermal expansion shifted back-reflection spectrometer described in detail. An average size of coherently scattering regions equal to about 8×10^3 unit cells was found to be in best agreement with the width of the measured curve. Possible reasons for the discrepancy between the depths of the experimental and calculated curves are discussed.

SUONINEN, E., KARRAS, M., and LEVOSKA, J.: *A double-crystal soft x-ray spectrometer*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 71, Helsinki 1970, 20 pp. Sw.kr. 10.00.

The effect of the choice of various design parameters and the alignment of the instrument upon the resolution of an x-ray spectrograph in the region $\lambda \approx 5-10$ Å is discussed. The influence of the mosaicism of the analyzing crystals upon the resolution and the intensity is treated in detail. The relative advantage of perfect crystals at high Bragg angles is emphasized.

The construction of an instrument using two highly perfect calcite crystals (reflection face 211) is described. The operation of the instrument is tested with measurements of the $VK\alpha$ and $SK\beta$ lines at the parallel and antiparallel positions. The results are compared with previous work reported in the literature.

SUOSARA, EERO: *Group theoretical analysis of trigonal selenium energy bands*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 72, Helsinki 1970, 47 pp. Sw. kr. 10.00.

The group theoretical knowledge of selenium energy band structure and of the optical transitions are given. New results are the possible band structures at symmetry axes and the possible locations and symmetries of energy gap extrema. Particular attention is given to correlations and amounts of the representation names of the bands.

FUGLSANG NIELSEN, L.: *Elastizitätsmodul der Kompositmaterialle insbesondere Mörtel und Beton*. Acta Polytechnica Scandinavica, Physics including Nucleonics Series No. 73, Copenhagen 1970, 33 pp. Sw.kr. 10.00.

Ausgehend von Budiansky's heuristischer Analyse wird folgender einfacher Ausdruck zur Bestimmung der Elastizitätskoeffizienten E, K und G eines Mehrkomponentenmaterials aufgestellt.

$$X \approx \frac{1}{N} \sum_{i=1}^N X_i^c \quad [\text{Max } X_i / \text{Min } X_i \lesssim 10]$$

Hier ist X der gesuchte Elastizitätskoeffizient, X_i der entsprechende Koeffizient des i-ten Teilmaterials, c, die Volumenkonzentration des i-ten Teilmaterials und N die Anzahl der Teilmaterialien. Bei Luftmischung mit Volumenkonzentration $c_a \lesssim 0,3$ wird mit $1-2c_a$ multipliziert. Die Formel wird speziell dem E-Modul von Mörtel und Beton angepasst und mit einer Reihe von Versuchsergebnissen verglichen. Abgesehen von gewissen näher diskutierten Ausnahmen, wird eine relativ gute Übereinstimmung konstatiert. Als Beispiel für die praktische Anwendung der Formel wird das maximale statische E-Modul von Mörtel und Beton berechnet. Hierunter wird folgender Ausdruck für das E-Modul des Zementleims benutzt.

$$\text{Max } E_{\text{zementleim}} \approx 4,3 \cdot 10^5 (1-1,1 W/Z) \text{ kp/cm}^2$$

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